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THE

SCHOOL OF MINES

QUARTERLY.

NOVEMBER, 1880.

THE GENESIS OF OUR IRON ORES.

BY J. S. NEWBERRY.

IRON seems to be one of the most universally diffused elements in nature. The spectroscope reveals its existence in the sun and the fixed stars, and it is so generally present in all portions of the earth's crust that the rock of which it does not form part becomes conspicuous and remarkable from this circumstance. All soils contain it; it is held in solution in all surface waters, and it forms the pigment by which nearly all rocks are colored; its anhydrous oxide giving the reds, its hydrated sesquioxide the browns and yellows, its proto-salts, silicate, carbonate, etc., the greens and blues.

The almost universal diffusion of these salts of iron in soil and rock is shown by the change which takes place in their color when calcined. This change is most noticeable in the burning of brick clays, but grey and blue shales and sandstones are equally reddened by heat, and a fire can

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hardly be kindled in forest or farm, on mountain or plain, where the stones and soil exposed to its action do not give prompt evidence of the presence of this metal.

In the earliest formed rocks—those which resulted from the solidification by cooling of the exterior of the molten globe—iron must have been an important ingredient, and probably existed as we find it in the igneous rocks of the modern world, that is as silicate and magnetite in the greenstones and basalts, and hematite in the red porphyrys and red scorias. We nowhere find in these igneous rocks erupted masses of iron, but it is always sparsely, often uniformly diffused through them. In their decomposition it is disseminated particle by particle through the resulting sedimentary rocks, or is concentrated mechanically or chemically to form deposits of iron ore; the first as black sand, the second as hematite, limonite or siderite in beds, veins, etc.

The oldest existing rocks of which we have any knowledge—the granites, slates, etc., of the Laurentian and Huronian series—are metamorphic in character, have once been sediments, and are the ruins of pre-existent rocks igneous or sedimentary. In these rocks iron is an important constituent of the most common minerals, hornblende, garnet, biotite, etc., and also occurs in sheets and masses more commonly of magnetite in the granite, of hematite in the slates. These deposits of iron ore, which are frequently of enormous size, were once universally and are now exceptionally regarded as eruptive in character; but we shall endeavor to show that they are all of sedimentary origin. The arguments in favor of this view are both negative and positive. First, as has been stated, we have never found in any quarter of the globe masses of iron ore among the products of volcanic eruption, nor any disconnected with either metamorphosed or unchanged sedimentary rocks; and, second, all the deposits of iron ore which are accumulating at the present day are the products of chemico-

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organic processes. To demonstrate this, let us take iron in what we may regard as the condition most like that in which it existed in the first formed crust of the globe, and let us follow it through the many changes that are wrought in it by nature's forces now in operation. In the more compact igneous rocks the iron is usually in the condition of magnetite; and on exposure these rocks soften and rust, that is, the contained iron is converted into the hydrated sesquioxide, with a change of structure which produces exfoliation. The iron oxide then mingles as a powder with the resulting soil. Here it is exposed to the action of acids which are generated by the decay of the almost universal sheet of vegetation, viz., carbonic, humic, crenic, apocrenic acids, etc. These dissolve it, and it then comes to be a constituent of the surface drainage, to be transported a greater or less distance, and deposited in one or another of the various forms of iron ore.

In like manner the iron contained in the minerals found in granite—garnet, hornblende, etc.—is either distributed mechanically by erosive agents through a mass of debris, or it is dissolved out atom by atom by the organic acids. The great beds of hematite and magnetite which lie in the Archaean rocks are subject to the same mechanical and chemical destructive agencies. The immense deposits of iron pyrites which we find both in the older and newer formations, undergo a somewhat different decomposition. These generally absorb oxygen, to form with the sulphur sulphuric acid. Sometimes this unites with the iron to produce a soluble sulphate, which being all removed, leaves cubical cavities or a silicious sponge in place of the crystallized or diffused pyrites; or the sulphuric acid is joined to some other base, leaving the iron perhaps in its original form, but converted into limonite.

Having now got the insoluble peroxide of iron into a soluble form, let us follow it in its travels. All the drainage of a forest-covered country may be asserted to contain

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iron. Where the rocks and soils hold this metal in unusual quantities the amount dissolved and transported is proportionately great, and many of the springs are chalybeate. Wherever these solutions of the salts of iron are exposed to the air they absorb oxygen, and the iron is converted into the hydrated sesquioxide. This we see in the precipitate of iron springs as yellow ochre; in bogs and pools it forms an iridescent film, which, when broken, sinks to the bottom of the water. If it there finds decaying organic matter, it is robbed of a portion of its oxygen, which unites with the carbon to form carbonic acid, and this, bubbling to the surface, escapes. The iron thus becoming again a soluble proto-salt, and floating off, absorbs more oxygen, and carries this also to the organic matter, continuing to do this until all is oxidized; then it is precipitated as limonite or bog iron ore. Thus it will be seen that, under such circumstances, iron plays the same part that it does in the circulation of the blood, where it is oxidized in the lungs and carbonized in the capillaries, serving simply as a carrier of oxygen.

The highest authorities in chemical geology are agreed that all the accumulations of iron ore which are now forming under human observation, are produced by the processes I have described; that is, by the reducing action of organic matter ferric oxides are converted into ferrous oxides, and being thus rendered soluble are leached out, transported to greater or less distances, and precipitated under favoring circumstances in the form of hydrated sesquioxide or of carbonate. They are also agreed in regarding the deposits of ore which date back to more or less remote geological times, such as the hematites and magnetites of the Palæozoic and Archæan systems, as the effects of similar processes of accumulation, subsequently changed physically and chemically by the agents which have metamphosed the associated rocks. Although we can not correctly class iron among the organic deposits—since but little of it has

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formed part of plant or animal tissue—organic matter is so distinctly a link in the chain of causes and effects by which accumulations of iron have been produced, that we are compelled to regard all iron ore deposits as the results of organic forces, and proof of the presence of animal or vegetable life as an accompaniment of their formation. Hence in the Laurentian and Huronian formations, formerly designated as the Azoic or lifeless rocks, where some of the greatest iron ore beds occur, the iron may be accepted as evidence of abundant life at the epoch of its deposition. This evidence is also strengthened by the almost constant association of phosphorus with iron, as phosphorus is to a marked degree an organic element; and by the great beds of limestone which are interstratified with the older iron ores and which are distinctly organic deposits.

In order that the application of the foregoing conclusions to our iron deposits may be appreciated, I will briefly review some of the facts which they present and which I have myself observed.

The most important deposits of iron within the territory of the United States may be grouped according to their geographical positions and geological ages, as follows:

1. The Laurentian magnetites of the Alleghany belt and Adirondacks.
2. The Huronian hematites and magnetites of Lake Superior and Missouri.
3. The Lower Silurian (?) ores of Southern Utah.
4. The Clinton hematites.
5. The Coal Measure carbonates.
6. The Limonites of the Alleghany belt, the Tennessee Valley and Missouri.

THE LAURENTIAN MAGNETITES.

These are best shown in Essex, Clinton, and Orange Counties, New York, in northern New Jersey, and in western North Carolina, although they form a nearly consecutive series of ore deposits from northern New York to

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North Georgia. They consist of lenticular sheets of greater or less extent, and varying in thickness from a few inches to one hundred feet or more. They are contained in beds of gneiss and mica schist, which are accompanied by slates and marbles. There can be no question that the associated rocks are metamorphosed sediments, and were once shales, sandstones and limestones. All these are now much disturbed, folded and faulted, usually standing at a high angle. Hence the ore sheets have much the aspect of veins, and they have been considered such by some geologists, while others have regarded them as eruptive masses. They have been, however, carefully studied by the members of the geological corps of New York, and by Prof. Cook, Prof. Lesley and Prof. Kerr, respectively State geologists of New Jersey, Pennsylvania and North Carolina, as well as by many other geologists, and all these have not only been satisfied themselves, but have furnished proof that has been convincing to others, that they are really beds deposited contemporaneously and conformably with the associated sediments, and that in the elevation and metamorphism of the mountain belt where they are found they have been changed to magnetites in composition, and by pressure, when softened, have been variously pinched, bunched, and contorted. Characteristic impurities of this series of iron ores are sulphur and phosphorus—which may be regarded as collateral evidence of their organic origin—and titanium, a common mineral in this geological zone, and sufficiently abundant in some of the ore beds to destroy their economic value.

In the Laurentian area of Canada, magnetic iron ores are as common as in the Alleghany belt, and exhibit the same physical and chemical characters. They have been carefully studied by Sir William Logan and Dr. T. Sterry Hunt, and have been by both regarded as metamorphosed sediments.

THE HURONIAN ORES OF LAKE SUPERIOR AND MISSOURI.

The iron ores of these two somewhat widely separated districts occur at essentially the same geological horizon and

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have similar mineralogical characteristics. On the south shore and at the west end of Lake Superior the Huronian rocks consist of slates, metamorphic (?) diorites, silicious marbles, &c., all of which are conformably stratified, and are recognized as the remains of a great series of aqueous sediments. This section of country has been exposed to the action of powerful eroding agents, and much of the Huronian series has been removed. In this process the masses of iron ore, being more resistant, have been left in relief, and when first examined seemed to be projecting knobs and bosses of erupted material. They were described as such by Prof. J. D. Whitney, in Foster and Whitney's reports on the geology of the Lake Superior region, and in his " Metallic Wealth," published in 1854. Since that time careful studies of them have been made by Major T. B. Brooks, and Prof. R. Pumpelly, in the northern peninsula of Michigan, and by Prof. R. D. Irving and Mr. C. E. Wright, of the Wisconsin Geological Survey, in that portion of the belt extending into the latter State. A careful examination has also been made by Prof. Albert H. Chester, of important beds of iron evidently belonging to the same formation in Minnesota. All these gentlemen are agreed in their rejection of the theory that the beds of iron ore are eruptive in character, and they are united in the opinion that they represent ferruginous matter deposited with the Huronian sediments, and subsequently in various ways modified and concentrated by chemical and mechanical causes. Quite recently, Mr. M. E. Wadsworth, who has published a memoir upon the copper and iron deposits of Lake Superior, has revived the theory of the plutonic origin of the Marquette ore beds, but has offered no facts or arguments which will be convincing to those who have observed on the spot the phenomena presented by these deposits.

The associated strata are plainly aqueous sediments, as they are not unfrequently ripple-marked and sun-cracked, and the interlamination of thin sheets of iron ore and jasper

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is conclusive evidence in my mind of sedimentation. That in some cases the ore has been profoundly modified, both in character and position, since its deposition, is undeniable, but to be asked to believe that the ore sheets are intrusive is a greater strain upon my credulity than it can endure.

The iron ores of Central Missouri present much greater difficulties to the geologist. They have been so fully investigated by Prof. Pumpelly and Dr. Schmidt, that no detailed description of them is necessary here, and it will be sufficient to say that they are contained in a series of beds of so-called porphyry, which is regarded by some geologists as eruptive, by others metamorphic. In the decomposed porphyry of Iron Mountain the ore occurs in detached sheets, masses, or nodules, which would seem to be segregations from a condition of general diffusion; a state of things that might very well follow the complete fusion, in place, of an iron-bearing sediment. In Iron Mountain, however, the ore is distinctly bedded, and though regarded by those who have most carefully studied the deposit, as an impregnation of a bedded porphyry, it is difficult to resist the conviction that it is instead a highly metamorphosed bedded deposit of iron. It appears certain that the Missouri iron region has been the theatre of intense thermal action, and it is probable that the condition of things we now find there has been the result of a long-continued and energetic thermo-aqueous metamorphism, but there is probably no competent observer who, upon an examination of the district, would reach the conclusion that the iron-ore beds are eruptive.

The iron ores of Cornwall, Pennsylvania, exhibit a phase of thermo-aqueous action no less striking and instructive than do the Huronian ores of Missouri; yet, although intimately associated with masses of distinctly eruptive rock, they are not themselves erupted, but are plainly the result of the immensely energetic action of heated water and steam. In this respect they resemble the vein-stones and ore bodies which are found adjacent to trap dykes in the Far

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West, which, though not themselves erupted, are the products of thermal action engendered by erupted masses of molten rock.

THE IRON ORES OF SOUTHERN UTAH.

During the past summer, which I spent chiefly in Utah, I visited the deposit of crystalline iron ore of Iron County, in the southern part of the Territory. These ore beds have been long known and were to some extent utilized by the Mormons in their first advent, thirty years ago, but no satisfactory description of them has ever been published. As they constitute, perhaps, the most remarkable deposit of iron ore yet discovered on this continent, I have thought that some facts in regard to them might not be an unimportant addition to what is known of the economic resources of our country. The iron region referred to lies nearly three hundred miles directly south from Salt Lake City, and is situated in what is really the southern prolongation of the Wasatch Mountains. The iron ores occur in the northern portion of a subordinate range, which attains its greatest height in Pine Valley Mountain near Silver Reef. Thirty miles north of this point the ridge breaks down into a series of hills from one thousand to two thousand feet in height, which consist chiefly of grey fine-grained granite, with dykes and masses of trachyte and here and there outcrops of highly metamorphosed limestone. The ore beds form a series of protruding crests and masses set over an area about fifteen miles long in a northeast and southwest direction, and having a width of three to five miles. Within this belt the iron outcrops are very numerous and striking; perhaps one hundred distinct claims having already been located upon them, each one of which would make the fortune of a mining company if situated anywhere in the Mississippi Valley or the Eastern States. The most impressive outcrops are in the vicinity of Iron Springs, Oak Springs, and Iron City, of which localities the first and last

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mentioned are about twelve miles apart. Near Iron Springs the *Big Blow-out*, as it is called, is a projecting mass of magnetic ore, which shows a length of perhaps a thousand feet by a width of five hundred, and rises in castellated crags one hundred feet or more above its base.

At Iron Springs a still more striking exhibition is made by the Blair Mine, which is a ragged crest of magnetite, black as jet, formed by the upturned edge of the thickest of a series of sheets of ore, which rises like a ledge of bedded rock two or three hundred feet above the adjacent low lands. This outcrop is visible as a conspicuous black hill at a distance of several miles. The connections between the ore bodies of this great iron belt are obscured by the debris from the easily decomposed trachyte and granite. It is evident, however, that for some miles the iron ore deposits are continuous or separated by very short intervals, as the outcrops occur within a stone's throw of each other, and the surface is everywhere strewed with blocks of rich magnetic ore, enough in themselves to supply all the furnaces of the country for years. It would seem that the iron forms a number of distinct and closely approximated belts, which are the outcrops of beds that stand nearly vertical, and go down into the earth like huge walls.

There is considerable diversity in the character of the ore, though it is about equally divided in quantity between hematite and magnetite. Some of the beds of both are exceedingly dense and compact, while others, though rich in iron, are soft and can be mined with the pick. Most of the ore is apparently very pure, containing a small amount of earthy matter and no foreign minerals. Some of the ledges, however, contain a large quantity of silica, the magnetite being mottled with white quartz; and one of the largest outcrops, though showing many millions of tons of ore apparently quite pure, is thickly set along certain zones, evidently strata of deposition, with crystals of apatite from a quarter to half an inch in diameter and two or three inches

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in length. At this location many of the fragments are highly magnetic, and lodestone as strong as any known can be obtained there in great abundance. A few rods from this great outcrop is another of equal dimensions, in which the magnetite is apparently quite free from all impurities, showing neither quartz nor apatite. Near by is another exposure, perhaps a continuation of the last, of which the mass is half magnetite and the other half fine-grained and dense hematite. Across a narrow valley from this group the hillside is covered with fallen fragments of a rich but soft and dark hematite, and at no great distance the soil is colored blood-red by the decomposition of a hematite so soft as to make no other show above the surface. Near this latter location I noticed a line of outcrop of a very jaspery hematite, in some places only a ferruginous jasper closely resembling some of the more silicious ores of the Marquette district.

As to the age of this remarkable series of iron ore deposits, I cannot speak with absolute certainty, though they are apparently Lower Silurian.

The granite of the hills which contain the iron is finer grained and less compact than that which forms the great granitic axis of the Wasatch, and I suspect is the metamorphic condition of the quartzite beds which rest upon the Wasatch granite. Some of the iron ore beds in this granite are distinctly interstratified with it, and are certainly, like it, metamorphosed sediments. This is plainly shown at the Blair Mine, where the principal crest of the hill is a distinct sheet of stratified, regularly bedded magnetite, from thirty to forty feet in thickness, dipping toward the north at an angle of about eighty degrees. Parallel with this principal layer are other sheets of magnetite separated by strata of granite and varying from a quarter of an inch to ten feet in thickness, as perfectly parallel and regular as any series of sedimentary beds ever seen.

On the whole, the Blair Mine is the most interesting and

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instructive outcrop of iron known to me, and furnishes the most striking proof of the sedimentary origin of these wonderful ore beds. None of the other outcrops are so distinctly stratified, but the Big Blow-out at Iron City affords an equally conclusive argument against the eruptive theory; for while it appears to be a huge amorphous mass, like a hill of basalt, on examination it is found to be in large part composed of metamorphosed limonite; that is, magnetite, which has the botryoidal and concretionary aspect and radiated structure of limonite, and was plainly deposited from water.

With the exception of the great iron deposits of Southern Utah, the Far West is but imperfectly supplied with this metal. I have found magnetite and specular ores in small quantities in several places in the mountains of Oregon and California, and in the Rocky Mountain belt, and similar ores have been met with by prospectors and explorers in some of the districts which I have not visited. We have no evidence, however, that any other great deposits of iron exist in or beyond the Rocky Mountains. If it is true, which I do not believe, that there are anywhere iron ores that are truly eruptive in character, it is somewhat surprising that in the immense area where igneous rocks predominate in the Far West, no masses of eruptive iron ore have been met with. We have reports of eruptive masses of magnetite at Nijni Tagilsk, in Russia, and of hematite on the Island of Elba, but no observations have lately been made for the purpose of determining whether these are what they have been reported to be. The famous beds of magnetic and specular ore of Sweden have also been considered, up to a recent date, as eruptive, but Prof. Otto Torell, Director of the Geological Survey of Sweden, with whom I was associated in the Centennial Exhibition, assured me that all the deposits of iron which he had visited in Sweden were metamorphic and not eruptive, and that he had no faith in erupted ores of iron.

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THE CLINTON ORES.

One of the most remarkable, certainly the most considerable, and perhaps the most important deposit of iron in the United States, is that which is known as the *Fossil ore*, a characteristic and almost constant element in the Clinton group of the Upper Silurian. This is an oolitic or granular calcareous hematite, which is traceable all along the belt of outcrop of the Clinton group, from Dodge County, Wisconsin, through Michigan, a portion of Canada, across New York, Pennsylvania, Maryland, West Virginia, East Tennessee, and to Rome, in Georgia, where it is covered by more recent deposits. In this long line of outcrop it is nearly continuous, and forms one or more strata from three to twelve feet in thickness. The Clinton ore varies somewhat in character and richness at different localities, consisting of loose, flattened grains in Wisconsin, in East Tennessee of a highly ferruginous sandstone (there called the dye-stone ore, from its use as a domestic dye by the inhabitants,) and shows its typical characters at Clinton, Oneida Co., New York, and in the Broad-top region of Pennsylvania.

In the central portion of the interior basin, the Clinton ore is mostly buried, but in south-western Ohio shows itself distinctly in its proper place, but here is very thin. It is known to have its greatest development in a broad belt along the margin of the Silurian sea, of which the Archæan area, south of Lake Superior, the Canadian highlands, the Adirondacks, and the Blue Ridge, formed the northern and eastern shores. The oölitic or granular structure of the Clinton ore is its most striking peculiarity, and upon microscopic examination it is found to consist of concretions of iron ore formed around some minute marine organism or fragment of shell or crinoid. The most marked peculiarity of its chemical composition is the large and constant percentage of phosphorus it contains, a feature doubtless due to its truly organic origin. If we look over the world for an iron ore now forming which will illustrate the origin

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of the Clinton ore, we find it in the granular or "mustard-seed" ore of the Swedish lakes. This is an oölitic ore, consisting of spherules of limonite which have formed around minute particles of some foreign substance. The water which flows into these lakes is highly charged with iron, since it is the drainage of a district rich in this metal. In the lakes oxygen is absorbed and ferrous is converted into ferric oxide. This, collecting around some nucleus, ultimately sinks to the bottom, a ferruginous oölite, which from time to time is gathered as a crop. The Clinton ore was apparently formed much in the same way. The basin in which it accumulated was surrounded by a watershed underlain by ferriferous rocks which furnished an unusual quantity of iron to the draining streams. This iron was precipitated in granules, which in successive ages formed beds many feet in thickness. Then a change of physical condition threw down upon it a sediment of another kind, and it was ultimately buried beneath all the Devonian and Carboniferous rocks. By their weight its granules were compressed to flattened disks, and these were in some instances converted into solid rock; and, like all the older limonites, this has finally lost its water and has been changed to hematite. Here we have a simple explanation of the formation of a widespread iron ore, which, since cheap and effective means have been devised for removing the phosphorus it contains, is destined to play an important part in the future industries of the country.

THE CARBONATES OF THE COAL MEASURES.

The Carboniferous iron ores consist (1) of the bedded calcareous carbonates which form part of the sheets of Coal Measure limestone; (2) the kidney ores, concretions of earthly siderite in the clay shales, and (3) the black band, a ferriferous bituminous shale. Of these the first variety was evidently formed, like the Clinton ore, in lakes which from time to time occupied more or less of the area of the coal

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basins. Usually the calcareous ore caps the limestone and seems to have been produced during an interval when the water basin was becoming shallow and contracted, so that the iron carbonate which was held in solution by a large body of carbonated water was precipitated as the quantity of water was diminished. The clay iron stones are the products of times when the drainage into the coal basins was turbid with mud and yet carried much iron. When this mud settled the iron diffused in it gradually segregated to form concretions, the centres of spheres of attraction of somewhat uniform radius. At present the calcareous and argillaceous carbonates are absorbing oxygen and are converted layer after layer into limonite or hematite, and I have noticed that the calcareous sheets and nodules are prone to change to hematite, while the clay iron stones are always converted into limonite.

The black band ores were once carbonaceous muds composed of silt and completely macerated vegetable matter, deposited in water basins like the lagoons of some modern swamps. Here the abundant iron of the drainage water settled with the mud, but, curiously enough, the carbon of this mud in some way prevented the formation of concretions, and held the iron disseminated uniformly through the mass.

In all these Coal Measure ores the abundance of decaying vegetable tissue kept the iron in the ferrous condition, and hence the shales and sandstones are, until aerated, grey or blue, never red, and the iron is the carbonate of the protoxide.

THE LIMONITES.

Along the east flank of the Alleghanies and extending around into Alabama, Tennessee and Kentucky is an important belt of iron ores which are largely used, are well known to both the unlettered and learned, and yet have been something of a puzzle to all who have attempted to

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trace the history of their formation. All these ores whatever may have been said to the contrary, are superficial in character. They occupy crevices, basins and ore chambers in the underlying rock, cover with their sheets the slopes of hills, or form nodules and concretionary masses in alluvial beds of gravel or sand. They are evidently the accumulations of iron carried in the surface drainage, deposited by aeration and oxidation, and filling whatever receptacles were open to receive them. As calcareous rocks are notoriously soluble in atmospheric water charged with carbonic acid, we find in them the greatest number of caves, crevices and chambers, and both in this and other countries these are the common repositories of limonite. Much industry has been displayed in tracing the iron of these deposits to its source; but so far to little purpose, inasmuch as it is plain that it has come from many sources. The surface drainage of a country well supplied with iron in rock and soil has contributed its quota for ages; while the decomposition of pyritous rocks has supplied another portion, and finally the limestones which have been so extensively dissolved away in ages past have left their iron—frequently an important constituent—as limonite. Along the eastern flanks of the Alleghanies the Silurian limestones have furnished some of the material and many of the receptacles for this brown hematite ore; while in Alabama, Tennessee and Kentucky the Lower Carboniferous limestone, rich in iron, has lost its carbonate of lime, and left a residuum which, sometimes in place, keeping all its fossils, sometimes transported to a neighboring nidus, has formed deposits of iron which are destined to be the source of wealth for generations to come.

The formation of these limonite ores has evidently been going on from the Cretaceous age to the present time. The Cretaceous clays of Staten Island contain concretionary limonites that belong to this category, and similiar clays which are said,though with doubtful propriety to be Tertiary,

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at Hinsdale, N. Y., Brandon, Vt., and many other places, are accompanied by lignites and limonites. Some of these masses of limonite ore have been cast in moulds that have since disappeared by erosion or solution. These moulds have often been limestone chimneys or chambers, and the insoluble filling of these cavities now alone remains. Numerous examples of this kind could be cited in Pennsylvania and Virginia, and they have given rise to some wild speculation. The most recent suggestion I have seen is that they are stalagmites in caverns of which roofs and sides have disappeared in a catastrophic caving of the undermined surface; but so far as my observation extends limonite never forms supporting pilliars in caverns, and the explanation I have given is more concordant with the facts I have observed.

The necessary brevity of this article compels me to pass without notice some large and interesting deposits of iron ore which are known to exist, and in some instances are extensively worked in this country. But an exhaustive review of our iron resources would form a volume, and this sketch has a different and far more restricted scope. It was intended simply as an argument against the plutonic and in favor of the organic origin of our iron ores. To illustrate this argument I have given my views of the genesis of the more important deposits and varieties of iron ore found in this country. Other illustrations would doubtless have strengthened the argument, but it is already so well fortified that it hardly needs further confirmation.

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GOLD AND SILVER REFINING AT THE ASSAY OFFICE, NEW YORK CITY.

BY EDWARD E. SAGE, C. E.

THERE have been and still are a number of different processes by which gold and silver are refined. The one which was formerly in most general use was the nitric acid process.

After the proper proportion of gold and silver are inquarted and granulated, the granulations are treated with nitric acid, the acid dissolving the silver and forming nitrate of silver, the gold settling to the bottom of the pots. The solution, after being drawn off, is treated with sodic chloride (common salt dissolved in water), the silver being precipitated as the chloride of silver. The precipitate is then washed till it is "sweet," and reduced with iron or zinc to metallic silver. It is then refined by fluxing.

This process was used in the United States Assay Office till the year 1866, when Mr. Andrew Mason, the melter and refiner, introduced the present system or process.

This process consists of seven different operations:

(1.) INQUARTATION AND GRANULATION OF THE BULLION.

The gold and silver are sent from all parts of the country, consisting of bullion, amalgrams, plate, etc. These are melted and assayed, and are then turned over to the melter and refiner. The bullion is again melted in a large graphite crucible; the charge being made up so that the gold and copper shall not exceed one-third and one-twelfth parts of the entire weight of the metal. When the metal is melted and thoroughly mixed, it is granulated by pouring it into a cylindrical iron tank, three feet high by three feet in diameter, filled with cold water. A peculiar rotary motion is given to the metal as it is being poured.

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The tank is supplied with a copper colander, which, when the charge is all granulated, is raised by means of an iron crane, the water nearly all running off. It is then poured on an inclined iron table to allow the rest of the water to drain off.

(2.) SOLUTION OF THE GRANULATIONS.

The pots used for the parting of the alloy are made of case iron, three feet and a half and two feet in diameter, by three feet and two feet in depth, and are set on brick fireplaces.

There are four pots holding 160 gallons, and three holding 50 gallons. Each pot is covered with a funnel-shaped hood of sheet lead, with an opening 30 inches long, through which the charge is introduced, and which has a sliding door. From each of these hoods a flue leads to the condensing chambers, which are two in number, on the floor above; from the last of these a long winding leaden flue leads into the stack. Both chambers have platforms, on which coke is laid several feet in thickness; through this the fumes pass, and are condensed. These chambers are supplied with water sprinklers, so that a spray of water is continually cooling the atmosphere in the chambers. Nitrous fumes are furnished by nitrate of soda, acted upon by the sulphuric acid.

About 300 lbs. of the granulations are put in each of the larger pots, with about 650 lbs. of sulphuric acid, and 250 lbs. more of the acid is gradually added during three hours' boiling. The resulting solution is then run off by means of a siphon into the receiving vats on the floor below.

The fire being withdrawn, a partial charge of acid is added, and the gold residue is then taken out by means of a perforated iron ladle, and placed in two of the smaller pots. In these it is boiled for six hours, with three successive charges of about 300 lbs. of acid. It is then placed in the third pot and boiled twice. The acid from the last five boilings is poured or run off into reservoirs on the floor, and is used again as a portion for fresh granulations.

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The gold is then placed in a washing-tub, where it is washed once with cold and twice with warm water; this water is poured into the washing-tub, from which, on settling, the solution is run into a large tank on the floor below.

(3.) TREATMENT OF THE GOLD RESIDUE.

The gold is now emptied into one of the filters, washed thoroughly with warm water till it becomes "sweet," and then drained. It is then boiled in two charges of acid for four hours, and again washed and sweetened. (When it is desired to make very fine metal this process is repeated.) It is then thoroughly drained and pressed into cakes by a hydraulic press.

(4.) MELTING AND REFINING THE GOLD.

After the gold residue is pressed into cakes, these are placed in an oven and dried. They are then taken to the melting room, where they are broken up and placed in a graphite crucible, fluxed from three to five hours, and run into bars, varying from 997½ to 998½ thousandths in fineness.

(5.) TREATMENT OF THE SILVER—THE REDUCTION OF THE SILVER.

There are for this operation four reducing vats, two concentrating vats, eight crystallizing vats, and three filters, 2 ft. 9 inches in diameter by 19 inches deep, with a space below. Two tanks on a high platform receive the washings from the gold.

The size of the reducing, concentrating, and crystallizing vats varies, on account of having to accommodate them to a given space.

The vats and tanks are made of wood and lined with heavy sheet lead. The reducing and concentrating vats are heated by a system of coils of lead pipe, through which steam passes. These vats are enclosed, and connect by a flue with the stack.

Before the sulphate of silver is run into the vats, ingots

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or bars of copper are placed on end around the sides and bottoms, next to the heating coils. The solution is then run in. A sufficient amount of water, together with the weak solution obtained in washing the gold, is added, to reduce the strength of the solution to 15° to 25° Baum, which has been found to facilitate the reduction. The sulphuric acid leaving the silver to attack the copper, the silver is precipitated or deposited as metallic silver. It requires from five to six hours boiling to complete the reduction.

The resulting copper solution is run off through a filter into a concentrating vat. The silver remaining on the copper bars is scraped off, and the whole is put in a filter. Copper hoes and shovels are used in the handling of the silver. About two hours washing with warm water is required to "sweeten" the silver. It is then drained in the draining boxes, pressed into cakes by the hydraulic press, and dried in an oven similar to that used for the gold.

When silver containing little or no gold is operated upon, 350 lbs. of granulations are dissolved in one pot. With baser metals, the charge of granulations is reduced, copper requiring much more acid to dissolve it than silver.

(6.) MELTING AND REFINING THE SILVER.

The cakes are broken up and placed in graphite crucibles, and fluxed with nitrate of soda, borax, bone ash, and a little soda ash. These re-agents absorb the little base metal which remains, as the sulphate, in washing. From four to six hours are required for fluxing. The silver is then cast into bars of 998½ to 999½ thousandths fine.

(7.) TREATMENT OF THE SULPHATE OF COPPER.

The solution of copper being run into the concentrating vats, is boiled until it reaches the strength of 40° Baumé. It is then run into the crystallizing vats. In several days the crystals are formed and the mother liquor is run off into the large tank on the floor below, from whence it is run into the carboys or tanks of its purchasers.

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The crystals of sulphate of copper are taken from the sides and bottom of the vats and drained. They are then dissolved in water and run back into the crystallizing vats at a strength of 32° to 34° Baumé. The sulphate of copper again crystallizes, and the mother liquor is put back into the concentrating vats. The crystals are then taken from the vats, dried, put into barrels and sold.

If lead is present to any extent in the bullion, it is removed by cupellation before it is granulated.

The consumption of copper is greatly economized in the reduction of silver by melting silver deposits free from gold and under, say, 400 fine with the copper used for that purpose. The silver in them is thus obtained pure without a direct parting, the copper alloy taking the place of that amount of the purchased metal that would otherwise be used.

The form and size of much of the apparatus used, were determined not only by the size of the space that could be utilized, but by the necessity of harmonizing the introduction of each stage of the sulphuric with the nitric acid process, until it was clearly seen by actual experiment that the former was rational as well as superior to the latter.

The proceeds of the sale of the sulphate of copper crystals and the liquor, nearly cover the total expense of the acid and bar copper bought.

All the wood used, after it becomes useless, is burnt. The old, unserviceable crucibles are broken up and ground. (The grains obtained from them are melted and treated as before.) It is then put through a rough washing and amalgamation process, the resulting trailings being dried, assayed, barrelled and sold to sweep smelters.

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THE VOLUMETRIC DETERMINATION OF COPPER.

BY ARTHUR H. ELLIOTT.

THERE are many methods which give most accurate results in the estimation of copper gravimetrically; but of the volumetric methods there is not one that for simplicity of manipulation and practical accuracy can be compared with the method in which an ammoniacal solution of copper is decolorised by potassium cyanide.

Much has been said against this process, and many have rejected it because they could not get results comparable with those obtained by precipitation and by the electrolytic methods. I will not claim for this process the accuracy of the gravimetric methods; but for technical purposes it gives good results, and its great merits are simplicity and ease of execution.

The process depends upon the fact that, if a solution of potassium cyanide is slowly added to an ammonia solution of copper, the dark blue color of the copper solution gradually disappears, passing through various shades of blue to peach blossom, and finally becomes colorless.

The source of most of the ill success of workers with this process is due to the fact that they vary the conditions of the experiments. Various quantities of ammoniacal salts have an influence upon the quantity of potassium cyanide used for a given amount of copper. Ammonia also has a similar influence. But it will be seen further on that it is easy to control these circumstances and have uniform conditions for all estimations of copper.

The following metals affect the process because they form double cyanides with potassium cyanide, *zinc*, *manganese*, *cobalt*, *nickel*. But since these are not often found

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in copper ores, or, with the exception of zinc, only in small quantities, they do not interfere with the practical accuracy of the process. In the case of zinc the ores should be tested for this metal, and if it is present the copper must be determined by some method other than potassium cyanide. It will be found that in practice zinc does not often occur in copper ores.

To prepare the cyanide solution, dissolve 55 grams of potassium cyanide (that known as *pure gold cyanide*) in one litre of water. This will give a solution, one cubic centimeter of which will be equivalent to .01 grams (about) of copper. When dissolved, the solution should be clear, and if any insoluble matter is present allow it to settle and draw off with a syphon into another bottle. Keep it in a cool, dark place, and it will not change in several *months*.

To standardize the solution thus obtained, pure electrotype copper is taken. About two decigrammes are carefully weighed and placed in a flask holding about 500 cubic centimetres. Ten cubic centimetres of pure concentrated nitric acid is now added to the flask and the copper dissolved by gently heating the flask. When all action has ceased, boil off the excess of nitric acid, until the residue in the flask is of a syrupy consistency. The flask is now about two-thirds filled with cold water and ten cubic centimetres of strong ammonia solution (·88 S. G.) are added. To the dark blue solution thus obtained, the solution of potassium cyanide from a burette is added, in not more than five cubic centimetres at a time, shaking vigorously after each addition; and as the blue color disappears, the cyanide is added with greater caution, until the blue color gives place to a peach-blossom. Now, wait a few minutes, and if the color does not disappear, add a few drops more cyanide solution and wait, proceeding with care until the solution becomes colorless. Two or three experiments of this kind will give the value in copper of one cubic centimetre of potassium cyanide solution.

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The application of this process to ores of copper is very simple. To prevent the annoyance which occurs from the separation of sulphur when sulphides are treated with nitric acid, it is best to submit the finely-powdered ore to a preliminary roasting before treating with nitric acid. For this purpose one gramme of the ore is taken, placed in a small porcelain crucible over a Bunsen's gas-burner, and carefully stirred with a piece of platinum wire until it ceases to give off any appreciable quantity of sulphurous oxide. The crucible is now allowed to cool, and the contents are transferred to a flask holding about 500 cubic centimetres. Ten cubic centimetres of concentrated nitric acid are taken, a few drops placed in the crucible from which the ore has been transferred, and the rest is run upon the ore in the flask. The crucible is now warmed, and its contents are washed into the flask with a fine jet of water. By this means the whole of the ore is transferred to the flask. The contents of the flask are now heated, and if the roasting of the ore was properly conducted, the copper oxide will readily dissolve and there will be no clots of sulphur separated. In addition to the copper oxide, some ferric oxide will also dissolve, but the greater part of the iron will remain insoluble in the nitric acid; all the copper going into solution. The contents of the flask are boiled until they become syrupy, and after cooling they are diluted with cold water, till the flask is about two-thirds filled. Ten cubic centimetres of strong ammonia solution (·88 S. G.) are now added, and the whole vigorously shaken and allowed to settle a little to judge of the amount of copper present before running in the potassium cyanide solution. If the solution is colorless to begin with, it may still contain some copper, and a few drops of cyanide solution and a vigorous shaking will bring out the characteristic peach-blossom color. If there is a difficulty in seeing the color, filter a little of the fluid through a small filter into a test-tube. As a rule the solution will be blue enough to be seen in the

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supernatant fluid over the settling ferric oxide, and will give the operator an idea of the amount of cyanide to be added. Care should be taken to add the cyanide slowly, shaking vigorously, and allowing to settle after each new addition. If it is not easy to see the color by settling, use a small filter and test-tube as above mentioned, returning the fluid to the flask, but rejecting the filter and adhering fluid and precipitate. As soon as the solution is colorless the operation is finished. An excess of cyanide gives a yellow color.

I have not had an opportunity to compare this process with the electrolytic method; but a comparison of its results with those obtained when the copper is precipitated as cuprous sulphide shows in an average of five analyses made by me; by the KCy method, 3·376 per cent.; by the Cu_2S method 3·421 per cent., and none of the individual analyses varied by more than 0·23 per cent. A comparison of the results of this method and those obtained by a Cornish chemist working on the same ores by the Dry Assay process, gives as an average of eleven analyses: by the KCy method, 2·642 per cent.; by the Dry Assay, 2·596 per cent. The greatest variation between the two was 0·7 per cent., and the least, 0·08 per cent.

These figures are taken from actual laboratory work, and although they are not as close as could be wished for, yet they proved to be all that was necessary in a technical work. The Dry Assays were done on the same cargoes of ore, but not on the same samples.

By following the directions given above, and having a solution of potassium cyanide ready, a determination of copper in an ore can be made within two-tenths of the truth in one hour, and if there are three or four determinations to be made, these can be run in the same hour, using separate sets of crucibles, flasks and burettes.

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PAPER-HANGINGS.

BY A. L. COLBY.

PAPER-HANGINGS, or wall-papers, as they are commonly called, may be defined as a covering for the interior walls of buildings, made of paper, and usually decorated with figures and designs. They were brought into use as a substitute for hangings of cloth and tapestry.

The art of making paper-hangings originated with the Chinese. The time of its introduction into Europe seems to be a matter of some little doubt. It is stated by some that as early as 1555, wall-papers were made in both Spain and Holland. Others assert that the English were the first to import and imitate Chinese paper-hangings. But the English, being exposed to a high excise duty upon the manufacture, were soon outrivalled by the French, who have brought the art to its high state of perfection, as they are unchecked by taxation.

The manufacture of paper-hangings, as a leading industry, is of comparatively recent date. This is due to the great reduction in the cost of manufacture, and the consequent increased demand for the article, owing to the introduction of machinery in printing the different colored designs, thus doing away with block-printing to a great extent; and also to the invention of the Fourdinier paper-machine, by means of which strips of paper of an indefinite length may be cheaply made. Previous to the invention of the paper-machine sheets of paper of the size called "elephant," 22x32 inches, were pasted together to make 12 yard lengths before the pattern was printed.

In the early stages of the art the method used to apply the patterns to the paper was a process of *stencilling*. This was accomplished by laying upon the paper, in an extended

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state, a piece of pasteboard, having spaces cut out, of various figured designs, and applying the water color with a brush. Another piece of pasteboard, with other patterns cut out, was next applied when the former figures were dry, and a new set of designs were thus imparted to the paper. By a series of such operations a tolerable pattern was executed, but with no little labor and expense—each differently colored portion of the pattern requiring a separate stencil-plate.

The processes of calico-printing were next resorted to, in which engraved wooden blocks were employed to print the designs. These are still in use. The greatest improvement, however, has been the introduction of machine-printing. This has made it possible to manufacture large quantities of the article at a much less expense than by the tedious method of block-printing. Machine-printing has now reached such a state of perfection that only those skilled in the trade can distinguish machine from hand-made paper-hangings.

The paper used is unsized, and may be either white or colored. The weight of a single roll, which is eight yards in length for machine-printing and nine yards for hand-work, is determined in ounces—the paper being known as 16, 20, or 25-ounce paper.

The first operation is the application of the ground to the paper. The pigments used are opaque, and are mixed with size; this is generally clay and a little glue, the clay being used as it absorbs the wet colors which are subsequently printed on.

The grounds are printed on the paper by a single roll machine, in which the paper passes over a large drum, and the color is applied by a revolving brush, the excess of color being taken off with two more brushes, so that a perfectly even coat is obtained. As the paper runs from the machine it is suspended in long loops from sticks, which rest on a slowly moving endless chain arranged near the ceiling,

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being thus carried the length of a long room, the temperature of which is maintained at a high degree by steam apparatus. By this means the paper is rapidly and thoroughly dried.

If the paper is to be "satined" or glazed, the ground is prepared with gypsum or plaster of Paris, and the surface dusted with finely-powdered steatite or French chalk. When this ground is dry it is passed through a series of brushes which revolve with great rapidity, thus giving an evenly polished surface.

A pretty effect is obtained by dusting finely divided mica on the grounds while they are still wet.

For very cheap wall-papers no ground is used, but the pattern is printed directly on a colored paper.

The figured patterns are printed on by two methods.

1. *Block-Printing*. This is the slower but more accurate process, and therefore better adapted for fine work. The process is conducted precisely as in the earliest days of paper-hangings. The blocks are about two inches thick, and are formed of three separate boards glued together, of which two are poplar, and one (that which is engraved) of pear-tree or sycamore. As many blocks are required as there are colors and shades of color in the pattern. Of course, the whole beauty of the work depends upon the nice adjustment of one portion of the pattern to the other, and this is accomplished by guide pins in the corners of the blocks, which are so managed as not to disfigure the surface with their points. In printing, the workman employs the same "swimming tub" apparatus which was used in calico printing. The block is pressed down by a lever worked by the foot.

When a piece has received one set of color impressions, it is taken to the drying-room, and dried previous to its receiving the next color. All the colors are applied in the same manner.

A well-drawn pattern may produce a very beautiful

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effect. The history of Psyche and Cupid, by M. Dufour, has been considered a masterpiece of this art, rivalling, it is said, all the productions of the pencil in the gradation, softness, and brilliancy of the tints.

2. *Machine-Printing.* Most of the decoration of paper-hangings is now done by machinery. The pattern is engraved in parts on a series of copper cylinders, each one of which furnishes a different color or shade of color to the pattern. The cylinders are so arranged below the large central drum, as, by the sum of their revolutions, to make the pattern complete, so that as the web of paper coming over the drum, passes the first cylinder, it receives the color for one portion of the pattern and reaches the second in exact time to have the next color applied in the right place. In this way the entire piece only occupies a few seconds in receiving the complete decoration. The paper is dried as in the printing of the grounds.

The better class of paper-hangings are embossed when the printing is finished. This is done by passing them through a machine which consists of two finely grooved rollers, one made of pressed paper and the other of steel. This embossing adds greatly to their appearance, as it brings out the pattern far more clearly. *Raised* papers are made by being first printed and then pressed in a suitable machine.

The application of gilding adds greatly to the appearance of the paper and is now used to a great extent. The gilding is made of alloys differing somewhat in composition from bronze gold. Silver and copper are perfectly imitated by varying the composition of these alloys. The pattern is printed on by varnish, and the powder is either dusted on by hand or else the paper is run through a machine consisting of various soft brushes which apply as well as remove the excess of the gilding.

Flock Papers require a special process to give them the well-known roughened and velvety appearance.

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The *flock*, as it is called, consists of finely divided shreds of waste woolen cloth. This is scoured and dyed. It is then stove-dried and ground to a fine powder; the requisite degree of fineness is secured by successive sifting in a bolting apparatus. Flocks are applied to the paper after it has undergone the usual printing operations.

A mixture called "encaustic," made of linseed oil boiled with litharge and ground up with white lead is used, as an adhesive basis for the velvety powders. The printing is done in the same way as in block-printing, the block bearing in relief only the pattern desired to be flocked. If a plain flock paper is to be made, this adhesive material is spread uniformly over the surface.

The paper is then placed in a drum, and the flock sifted over it. This drum is a long rectangular box with a bottom of calf-skin. Wooden rods are so arranged underneath this bottom by springs and a connection with an iron shafting running along underneath the drum, that on rotating this iron shafting these rods beat violently up against the under surface of the calf-skin. This causes a cloud of flock to rise in the drum and uniformly coat the prepared portion of the paper.

Arsenical Paper-hangings.—Since Prof. Gruelin of Heidelberg called attention, in 1843, to what he deemed the deleterious effects of living in rooms whose walls were decorated with green paper, this subject has been repeatedly investigated in all its relations. From a comparison of the results of investigations conducted by distinguished scientific men in France, Germany, England and America, there is little room left for doubt concerning the harm, which may result, under certain conditions, from the use of arsenical wall-papers. Some investigators, comparatively few in number, have arrived at a contrary conclusion; their experiments seem to have been conducted on a wrong basis, or else, they have shown partiality in their statements.

For the purpose of discussing this subject, wall-papers

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may be divided into three well-defined varieties, according to the methods used to attach the coloring matter to the surface of the paper. These are:

1. Unglazed; 2. Flock; 3. Satined.

The first of these classes, those which have an unglazed surface, are the most likely to produce harm: since the color is only moderately adherent and is removed by the slightest friction or vibration.

The *flock* papers are less open to this objection. The wool which constitutes the flock is dyed with vegetable colors, and if arsenical pigment is used it is found in the ground tint on which the flock is laid or in the green foliage found in the inter-spaces. The flock may not be poisonous in itself, but may become so, since it is easily detached from the paper, and may carry with it particles of the underlying color.

The *glazed* papers are the best, as regards safety. The polishing which gives them their gloss, serves to fix the pigment more securely, and it is only after long wear or by frequent dusting that abrasion in the glazing would be produced, and allow the dust of the pigment to escape.

The *quantity* of the poisonous color which is used upon paper-hangings varies exceedingly, of course; but occasionally it is found in large amounts. Prof. Bacon asserts: "Frequently so much as 50 or 60 grains of arsenical pigment are spread in each square foot of the paper."

Dr. Taylor states the results of his analyses to vary from 28 to 70 grains on the same surface.

The question, however, which most concerns us is—does the presence of arsenic in such large amounts on the walls of rooms habitually occupied by day and night, exert any deleterious influence on the health of the occupant?

This is a question which should be answered by conclusions drawn from recorded facts. Cases which are directly traceable to the influence of poisonous wall-papers are too numerous to be put aside. They rather form a mass of evidence which cannot be gainsayed.

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It will be unnecessary to cite a long list of authenticated cases in a paper of this kind. The medical journals for the past ten years, contain numerous instances of cases in which symptoms similar to those of arsenic poisoning were experienced, and in which, on removing the paper-hangings of the room, no further annoyance occurred. Such cases as these are only capable of one just interpretation.

They all point to the fact that the arsenical pigment of the paper-hangings affects in some way the occupant of the room, producing clearly marked symptoms of arsenical poisoning.

It is interesting, although not a matter of so much importance, to trace the various theories that have been advanced to explain the processes by which the poisoning pigment enters and affects the system.

Leopold Gmelin, who, as I have cited before, was the first to call attention to this subject in any of its relations, thought that the poison was absorbed as a volatile gas. This, he says, is due "to the product of a fermentation of the organic matter with which the arsenic is mixed." A little later, M. Louyet, of Brussels, declared that this gas was a form of arseniuretted hydrogen, produced, he thought, by the action of the moisture present in the walls of rooms upon the arsenic in the paper.

Another theory, undoubtedly erroneous, was that the poisoning took place by the inhalation of volatile arsenic fumes, which escaped from the paper. But arsenic is only volatilized at about 350° F. Jackson thinks that the presence of illuminating gas, which escapes in small amount, reacts on the arsenite of copper, to produce arseniuretted hydrogen.

These hypotheses are not accepted by the majority of chemists of to-day. It is the general belief that the poison escapes from the paper into the atmosphere in the form of dust, mechanically disengaged. This theory seems very probable when we think of the manner in which the color

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is applied to the paper. The adhesiveness of the size is relied on to a great extent. This does not grow stronger by age. The varying states of the atmosphere as regards moisture and temperature certainly loosens the pigments; so that, mechanical disturbances, as vibration, dusting and draughts of air, however small, serve to disengage a fine powder containing the poisonous agent.

This view is also well supported by facts. The dust resting on furniture, mantels, books, pictures, etc., has been analyzed, in all cases resulting in the proof of the presence of arsenic. Dr. Taylor, in his Treatise on Poisons, states that he analyzed the fine dust on some books in a book-case with glass doors, and found a well-marked quantity of arsenic. The room had been hung with an arsenical green paper, which it was supposed had caused some symptoms resembling arsenical poisoning in a friend who occupied the room.

He also mentions analyzing in another case the dust on the cornices and on the gold mouldings of the picture frames, with a like result. He adds, that care was taken in these experiments to remove the dust without touching the wall-paper. Such cases might be multiplied indefinitely, proving beyond doubt the theory that the poisonous effects are due to the mechanical separation of the pigment as a dust which, floating around the room, effects the occupant by its simple inhalation into the lungs and throat.

In closing, it might be well to say a word regarding the false impressions existant that mere inspection is all that is necessary to determine the character of a wall-paper. The two greens, Scheele's green, the arsenite of copper, and Schweinfürt green, the aceto-arsenite of copper, are perhaps the chief sources of the occurrence of arsenic in wall-paper. Of these, the former contains 55 per cent. and the latter 58 per cent. of arsenious acid.

These greens are largely mixed with white pigments, so that all varieties of shade are obtained.

It must be remembered that other greens, as chrome

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green, etc., are largely used in the trade, so that it would be unjust to condemn a wall-paper because it had a green leaf in it. Another point is that other colors than green contain arsenic, which is used in their manufacture. This is the case with rosaniline, in which arsenious acid is used as a reducing agent to convert the mixtures of aniline and toluidine into the aniline red. Now, as this is largely used in the trade, it adds another series of colors to the list of poisonous ones. Still another fact, which shows the fallacy of judging injurious wall-papers by inspection is that in quite a number of colors arsenic mordants are used to fix the color on the paper; hence it is easy to conclude that the *only* way to determine the character of paper-hangings is to subject them to at least a qualitative examination, and this may be done by any of the well-known methods.

STEAM HAMMERS.

BY M. J. O'CONNOR.

THE steam hammer, by definition, is a form of forge hammer, consisting of a steam cylinder and piston placed vertically over an anvil, the hammer rising and falling by the power of steam. Therefore, hammers that are worked by means of pulleys, belts, etc., as tilt and trip hammers, cannot be placed under this head.

Before the introduction of steam hammers, large forgings were obtained entirely by means of trip and tilt hammers; the word "large" being used here as meaning large in comparison with the forgings of that day.

The idea of a steam hammer was first conceived by the famous James Watt. He secured a patent for one in 1784, but does not appear to have constructed it. The matter was next taken up in 1806, when a William Deverell likewise secured a patent, but failed to construct the hammer.

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From this time until 1837 the subject appears to have been entirely lost sight of. At that time the increased traffic across the Atlantic caused a demand for larger and faster steamers. The steamers then in use were side-wheelers, and as they became larger the forging of the paddle shafts became more and more difficult. The crisis was at length reached when the engineer of the steamship "Great Britain," then in the course of construction, could find no forge master willing to undertake the forging of the paddle shafts. The engineer, in despair, finally applied to Mr. James Nasmyth, then at the Bridgewater foundry, to help him out of his dilemma. Whilst thinking it over, it occurred to Mr. Nasmyth that the long-forgotten steam hammer would hit the case exactly. He accordingly devised a plan for one, and showed it to the engineer, who approved of the scheme and set about having it put into practice. A change made in the mode of propelling the steamship rendered the shafts unnecessary, and the hammer was not then constructed.

Mr. Nasmyth, after vainly endeavoring to induce the different forge masters to join him in the experiment, determined to build one himself, and the first steam hammer was constructed at the Bridgewater foundry in the year 1843.

In this the iron head, or hammer proper, slides between upright guides in a frame. The cylinder rests on top of this frame. The piston rod, after passing through the brass cylinder head and stuffing box, is fastened to the hammer head. The cylinder is provided with a valve for the admission of steam below the piston; the valve being worked by a lever.

To operate the hammer, steam was admitted below the piston until the "head" had attained the required height; then the steam was cut off, an exhaust valve opened, and the head allowed to fall; the force of the blow depending on the weight of the hammer and the distance fallen through, less the force taken up by the friction of the piston and of the escaping steam.

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All hammers similar to the one just described were subsequently called "single-acting," and are Nasmyth's hammers. His name, however, has been lost among the many made use of in connection with improvements. The principal fault of this hammer was, that there were practically no means of regulating the force of the blow. When we consider that blows of varying intensity are constantly required, and that the hammer must rise immediately after striking, we can readily understand that the utmost care and attention would be required.

For a long time Mr. Nasmyth vainly endeavored to surmount this difficulty. Being called away on business, his partner, Mr. Gaskell, referred the whole subject to the engineer of the works, a Mr. Robert Wilson, who took the matter in hand, and in little more than a week attached an automatic arrangement to the hammer. This attachment consisted of a long vertical screw on which worked a nut. This nut was the fulcrum for the tappet-valve lever, which was worked by two catches on the hammer-head. By turning the screw, the position of the fulcrum was altered, thereby varying the time of opening the valve during the ascent or descent of the hammer. By means of this attachment any blow, from the heaviest the hammer was capable of giving, down to the gentlest tap, could be given with the greatest ease. An illustration of the delicacy of motion now attained was the placing of a wafer on a watch turned face upward and causing the immense hammer to descend and pick it off without the slightest injury to the watch.

From this time until 1861 Mr. Wilson made several improvements in the hammer. In 1861 he invented and patented an arrangement popularly known as the double-acting hand-gear motion. By this arrangement steam is admitted as before to *raise* the hammer, and when just about to descend, the steam is admitted above the piston, driving the hammer down with a force more than double that which it could exert in its previous condition. This

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improvement seems to have been made at precisely the right time, for the large iron-clad vessels then being built, necessitated the use of larger and stronger tools than any hitherto in existence.

From this time up to the present day no marked change has taken place in steam hammers, and the general shape at present differs very little from that of Nasmyth's first hammer.

The frame on which the cylinder rests consists of two broad legs, with space enough between them to permit the workman to manipulate the work easily. These legs are attached below to a large cast iron plate, which has a hole cut through it in the middle. Through this hole comes the anvil, the plate and anvil not being in any way connected as far as supports or braces are concerned. This separation of the hammer and anvil is to allow the shock of the blow to be taken up in part by the foundation of the anvil; thus guarding the hammer against one of its strongest agents of destruction.

Above ground the anvil appears to be an unassuming block of iron usually about 18 in. high, 3 ft. long, and 1 ft. thick. Modest though it be in appearance, the anvil and its foundations cost more than the hammer itself. The foundations usually consist of piles, concrete, and grillage. In building, the anvil is always raised 1 or 2 inches higher than the required height, to allow for settling, which takes place even in the very best built foundations. The following dimensions of the anvil foundation of the large steam hammer used at the Morgan Iron Works will give an idea of the proportion of the different materials. The hammer is about 20 ft. high, the head weighing about 5 tons. The distance from the top of the piles to the top of the anvil is 15 ft. On the piles rests a block of concrete 8 ft. high; above this is a layer of grillage 2 ft. thick; and, finally, a pyramid of concrete 3½ ft. high, supports the anvil. Such extensive foundations are of course unnecessary in the

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smaller hammers. In these the cylinder is supported by a single stout iron leg, the lower end having a broad and flat projection which constitutes the anvil.

One of the largest hammers in the world is at the Royal Gun Factory, Woolwich, where all the heavy guns of the British Navy are forged. It was constructed by Nasmyth & Co. From the floor to the top of the cylinder it measures about 50 ft. The head of this gigantic hammer is described as being as large as a sugar hogshead and weighing 30 tons. The anvil is level with the floor, and consists of a heavy cast iron plate resting on foundations as wonderful as the hammer itself. Immediately under the anvil are alternate layers of concrete and huge tablets of iron 1 ft. thick. Under these come heavy balks of timber, then beds of concrete, and finally piles.

The force of the blow that this hammer is capable of giving is estimated at 1,000 ft. tons. The furnaces and cranes surrounding it are of corresponding size.

The largest steam hammer ever constructed is at the Krupp gun manufactory. The hammer weighs 50 tons, and has a cylinder nearly 6 ft. in diameter. At each of the four corners is a 50 ton crane. The anvil face weighs 185 tons. In the inventory of the tools used at this place we find 49 steam hammers.

Different forms of steam hammers have been advanced at various times, and brief descriptions of two of them will not be out of place. The first was invented by Robert Morrison, of Newcastle-on-Tyne, in 1853, and differed from the ordinary tool in having the piston rod itself for the hammer. The rod was made very heavy, and for greater steadiness, was extended through both ends of the cylinder, the piston being attached to both ends of the rod. To prevent the rod from turning on its axis, a slot was cut in the cylinder head, and a corresponding thread attached to the rod. The striking end was provided with a shoe fastened on by a dovetail joint.

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This hammer gave satisfaction at first, but, after being a short time in use, the rod appeared injured, and was found to be shattered just above the enlargement. This hammer was improved in 1872, by William Seller, of Philadelphia. The improvement consisted in enlarging the rod just below the cylinder head, and continuing the enlargment down to the hammer face, thereby not only doing away with the previous fault (by bringing the centre of gravity within the enlarged portion of the rod and making it far less liable to shatter), but also increasing the force of the flow by increasing the weight. Such hammers are not now much used, as they are greatly inferior to the later patterns.

The second form was devised by a Mr. Ramsbottom, in England, and was successfully worked by him at the iron works at Crew. It consisted of two hammers, worked horizontally, through a system of levers, by a single cylinder. No anvil was necessary, the work resting on a bed-plate, whilst the hammers struck it simultaneously on opposite sides. One of the advantages was the decreased expense in having no anvil foundations to construct.

In erecting a steam hammer the greatest care and precaution are necessary. The axis of the cylinder must be perfectly vertical; otherwise, every time a blow is struck, severe side strains occur, which, in a short time, cause fractures fatal to the hammer. The strains, even when the cylinder is in proper position, cause an enormous amount of wear and tear. In large hammers this is to a certain extent obviated by having no rigid connection between the hammer and anvil. Everything about the hammer is usually of cast iron except the piston rod, which is wrought. In working a piece of iron, a shaft for instance, it is first lifted to the furnace by a crane and the end introduced into the furnace. The door is then built up and the blast turned on. It remains in the furnace until the proper heat is attained, the time depending on the size of the shaft and the capacity of the furnace. In a general way it may be

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said that it takes two hours to bring a shaft, 14 in diameter, to the proper temperature for forging. When this is accomplished, the door of the furnace is pulled down and the shaft run out and carrried by the crane to the hammer. There it is beaten out to the desired shape, the foreman testing the work every now and then with gauges. When the shaft cools down the same operations are repeated. It is desirable to raise the hammer immediately after striking, as the cold hammer face tends to cool the shaft rapidly, thereby necessitating frequent reheatings, and consequent loss of time and money.

The hammers used for tilting steel are light, and are worked with great rapidity. The number of blows per minute amounts, in some instances to 500. An enormous amount of heat is of course generated, which not only serves to keep the steel hot, but is capable of raising the heat from a dull to a bright red.

At the present time the steam hammer seems as near perfection as we can possibly imagine it. Its invention completely revolutionized the iron trade, and has rendered possible innumerable plans and constructions, which previous to its existence were declared impracticable.

Another class of hammers is now springing up, which may yet supersede the steam hammers. These are the hydraulic hammers. They are sufficiently powerful to ram the hot solid metal into moulds of the desired shape, giving stronger results than casting and more accurate shapes than can be obtained by the ordinary manner of forging.

What new departure will take place in this line remains to be seen, though it is doubtful that any will ever bring about such important changes as the steam hammer has done.

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CHEMICAL ACTION OF LIGHT.

BY F. WIECHMANN.

THERE is probably no other force, if we except electricity, that has been studied with greater care and labor by the scientist, than light; great scholars have devoted a lifetime to researches and obversations concerning this one subject, and the field of discovery is still promising to the explorer.

To us, naturally, the chemical part of the problem seems the most inviting, and it is in *this* line that most work has to be done.

The most common instances in the arts and industries in which light plays the part of chemical agent, are well known, and it will not be necessary to enter into these here; the object sought is rather to draw attention to the every-day effects of light that so often pass unnoticed, and yet exert so important a bearing on us and our surroundings.

As you all know, a ray of light will, when passed through a prism, split up into the different kinds of light which may exist together in the radiations of a luminous body. The different kinds of light are already there before the light enters the prism, but they are not distinguishable, the one from the other, because all fall together upon the same spot —they all enter the eye together—and the impression thus received of all the colors at the same moment, we call "white."

The chief colors of the spectrum, in their order, are usually given as red, yellow, green, blue, violet. Beyond the red there appears to the eye no further color, and beyond the violet there is a scarcely perceptible tinge, but yet there are rays of light beyond both the red and the violet; the former heat rays, and the latter rays of great chemical

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power, as is shown by their strong effect on the photographic plate (iodide of silver). If the photographic silver preparations are examined by means of spectrum analysis it is seen that they *absorb* the *blue* light. It has also been observed that flowers fade quickest in their complimentary colors; thus the violet fades quickest in yellow—roses quickest in green light.

From these facts was deduced the law which as yet stands without exception: that only that colored light can act chemically on a body, which, on entering, is absorbed by the same.*

This, then, brings us to examine the merit of the theory advanced by Col. Pleasanton a few years ago, and which at the time created no little stir in certain circles.

As you may remember, he claimed to raise plants to larger growth and greater perfection than could ordinarly be done, simply by covering his hot-houses with blue glass, and thus exposing the plants to the action of blue light. It is true he attained by his method very good results, and his plants surpassed in growth and strength others that had been raised under precisely the same conditions excepting their exposure to blue light; this, however, does not prove the more powerful chemical action of blue rays, the explanation lies in the simple fact that *blue* glass is heated to a greater degree by the sun-light than white glass, thus the temperature was more favorable in the one case than in the other.

The effects of light on the animal system are perhaps not so marked as in the case of plant-life; and yet they have on it an important bearing. "Plenty of light and air" has been and is the cry of our sanitarians, and justly so. In the crowded tenements of a city the want of sufficient light and air are the great contributors to the mortality list. By statistics carefully gathered, it has been proven that, all other conditions being the same, the presence or absence of

* Prof. H. W. Vogel.

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light affects in a great measure the health of the inhabitants of a dwelling. Never was there issued by government a decree more hurtful to the interests of the community, than the law made in England, I believe in the last century, imposing a tax of so much per window in a house. As a consequence, the number of windows placed in a building was reduced to a minimum, and the older houses in some towns of that country are even now remarkable for the absence of them.

One of the most common and generally noted chemical effects of light on animal tissue, is the process of "tanning." By this term is designated the changing of color of the skin when much exposed to the action of light. That this change is due to light and not to the air follows clearly from the fact, that those parts of the body which are fully exposed to the action of the air but shaded from the light—the forehead, for instance—do not tan.

That in plant life, light, above all, is the agent of creation and sustainance, is proven by innumerable facts and observations. In the process of germination, light is unnecessary, but as soon as the young plant has burst through its cover of earth, as soon as the first shoot is above ground, then enters as a most important factor in its life—light.

As a broad rule all plants are endowed with the power of converting inorganic into organic matter. The food of plants consists of the inorganic compounds, carbonic acid, ammonia, water and small quantities of certain mineral salts, among which are those of lime, phosphorus, silicon, etc. "From these, and from these *only*, plants are capable of elaborating the protoplasm which constitutes the physical basis of life; and this process, a process of deoxidation is rendered possible by the influence of *sunlight only*."*

It is not on the organic part of nature alone that light exerts its chemical action, the inorganic world as well is subject to its influence.

* Nicholson—Manual of Zoölogy, page 10.

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Thenæ and Gay-Lussac, at the beginning of this century, discovered that if two gases, hydrogen and chlorine, be be placed together in the same vessel and be kept from the rays of light, they remain separate and unchanged; if placed in moderately bright daylight, they combine with each other gradually; in very bright sunlight, however, they combine rapidly, this act being frequently accompanied by an explosion.

In this instance the effect of the light is one of combination, more frequently decomposition is the resulting action. It has been shown that pure quinine, extracted from the bark, is by the chemical effect of light changed into quinidine, a body that does not possess the fever-breaking property of the former.

Silver nitrate is decomposed by sun-light, silver chloride turns a violet color, and the iodide and bromide of the same element are very sensitive to its action.

Mr. T. P. Blunt remarks in the *Analyst*, that a solution of oxalic acid may be kept in good condition for any length of time in the dark, but when exposed to the light it undergoes rapid decomposition. Some solutions that were exposed to the light for six months in test tubes stoppered with cotton-wool, lost all traces of acidity. Dilute solutions of alkaline oxalates—ammonium oxalate especially—will undergo similar decomposition.

About forty years ago there was in Berlin a mirror manufactory which had placed on its show-window, formed of an exceptionally fine pane of glass, the word "Spiegelmanufactur" in brass letters. When after a long time the pane was taken down and the letters removed, it was found that, notwithstanding the thorough cleaning the pane received, the word still remained distinctly legible in the glass. It appeared that the glass was colored a yellow tint and had only its white color on those places where it had been protected by the brass letters from the influence of the light.

This change of color extended throughout the whole

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thickness of the glass, as was seen when the surface of the same was polished off. A piece of this pane in still retained in the physical department of the the royal university. This occurence at the time created much interest, now it is known that nearly all white glass is colored a yellowish tint, sooner or later, under the action of light.

At the meeting of the American Academy of Science, held at Boston during last August, Mr. T. Gaffield presented a paper on "The Action of Sunlight on Glass," which proved to be of great interest, as the experiments described therein were begun in 1863, and had been continued to the date of delivery. The experiments were very numerous, embracing the entire work of glass-making, including colored and colorless glass of foreign and domestic make. A general *resume* of the changes of color produced in colorless glasses; that is, glasses which appear colorless, when seen in thin sheets, but which, in thicker plates, show tints more or less distinct, is as follows: From white to yellowish; from green to yellowish green; from brownish yellow and greenish tints to purple; from light green or greenish white to blueish; from blueish and other tints to darker shades of the same color.

The experimentor claims that every kind of glass, except some of the white flint glass, such as is generally employed for optical goods, shows some change of color after long exposure to sunlight. It is a curious fact, that, no matter what change the color of a glass may have undergone by this means, the original tint can be restored by exposing it to the heat of a glass-stainer's kiln.

Before the discovery of photography, silhouettes were very much in use. It was customary to place them on a little board, cover them with a glass and then paste a strip of paper around the border. In this manner such pictures remained hanging in the same place, frequently undisturbed for years; by accidentally removing one of these, there was made the discovery that on the little board which covered

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the back of the silhouette, there was formed a plain copy of the picture, white on a brown background. The light had penetrated the white paper on which was pasted the silhouette, and had gradually turned the pine shingle of a brown color. The black silhouette had however kept back the light, and as a consequence the wood immediately covered by it had retained its natural color.

Paper frequently assumes a darker tint on long exposure to light, and cloth and silk are also affected in a similar manner.

Instances of these changes undoubtedly happen daily, but there seems as yet not to be sufficient general interest in this branch of chemical science for their observation; but even now the fact is established, that we have in light not only an *agent*, whose language interpreted by the spectroscope, tells us of the inmost being of the heavenly bodies, but a *reagent* unsurpassed by ought as far as power and universal application are concerned.

NOTES.

In accordance with the desire of the members of the Chemical and Engineering Societies, our exchanges will hereafter be placed in the library for reference by the students.

Experiments of Professors Bauschinger and Thurston, on specimens of iron which had endured respectively fifty and forty years of service, have shown that age has little effect on the quality of iron. The strength and elasticity of the specimens tested had not altered perceptibly from what they were reported to be at the time when they were put to service.

M. Debray, at a meeting of the French Academy, exhibited *an alloy which, when heated, will explode.* "A piece of it held near a gas-flame, will detonate, to the astonishment and alarm of the holder." It is composed of one part rhodium and two or three of lead, heated in a crucible to a high temperature.

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An important discovery in Stellar Physics has been made by Prof. E. C. Pickering, director of the Harvard Observatory. He finds that by placing a prism between the object-glass and eye-piece of his telescope, the light of a *star* is drawn out into a continuous band, while that of a *planetary nebula* is collected to a star-like point, thus enabling the astronomer to distinguish instantly between a star and planetary nebula.

Recent investigations tend to show that there is no such element as Davyum. Among the numerous alleged discoveries of new elements the atomic weights of nine have been determined, viz.: Scandium 45, Yttrium 89, Phillipium 111, Thulium 170.7, Terbium 147, Decipium 159, the Ya and YB of Marignac, respectively 156.7 and 149.4, and Ytterbium 172. This would seem to verify the suppqsed discoveries. Salts of the oxides of some of these metals have been formed, but only in very small quantities. The spectra of some of these salts are said to be very brilliant, and in some instances quite a number of bright lines are produced.

Professor Tait, of Edinburgh, estimates the power liberated during a rainstorm as follows: For a rain-fall of one-tenth of an inch enough heat would be produced in an atmospheric column one mile high, and with a section of one square foot, to raise the temperature of the air 3.3°C. The heat thus developed over one square foot, under these conditions, is equivalent to work at the rate of one-horse power for 12 minutes; and over a square mile this would be 10,000,000 horse power for half an hour!

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THE

SCHOOL OF MINES

QUARTERLY.

FEBRUARY, 1881

PHENOL OR CARBOLIC ACID—QUALITATIVE AND QUANTITATIVE TESTS.

BY E. WALLER, PH.D.

It is almost unnecessary for me to mention the source from which the carbolic acid is obtained, or the mode in which it is prepared; a brief mention of these points, however, may not be here considered out of place.

The coal-tar contains substances which have been grouped as follows:

Bases.—Ammonia, methylamine, ethylamine, aniline, quinoline, picoline, pyrridine, toluidine, etc.

Acids.—Acetic, rosolic, and brunolic, etc., with what are really phenols, though they have been called acids, carbolic acid, or phenol, cresol, phlorol, thymol, etc.

Neutral Substances.—Benzene, toluene, cumene, cymene —liquids: anthracene, chrysene, pyrene—solids.

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In this country the method of obtaining commercial carbolic acid or crude phenol, is usually as follows: The portion called the "light oil" is distilled off at temperatures below 350° or 400° F. Steam is then passed through this light oil until no more of the oil can be carried off in this way. The mixed steam and vapor is condensed, the latter affording what is known as "refined coal-tar naphtha," and consisting of (benzol) benzene, with some admixture of (toluol) toluene. What has not been volatilized by use of the steam is known as "naphtha tailings," and contains the most of the phenol in the original coal-tar. In England a somewhat different method is employed. A fraction coming off at lower temperature is first distilled off for the naphtha and the residue is treated for phenol. In either case the phenol is obtained by agitating the material with an aqueous solution of some fixed alkali, and after separating the alkaline solution from the oil which does not dissolve, neutralizing the alkali with an acid, which liberates the phenol.*

As carbolic acid or phenol is often called coal-tar kreasote, and indeed resembles kreasote in many respects † it is often necessary to distinguish between the two, or to detect any addition of the former to the latter.

The tests most relied upon for this purpose are

1. The solubility of the sample in glycerine ‡ (Gr. 1.258.) Carbolic and cresylic acids (phenol and cresol) will dissolve, while kreasote does not, at least unless less than half the sample consists of creasote.

2. The action with collodion. Kreasote does not coagulate collodion (precipitate the nitro cellulose) while phenol does.

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* *Vide* Commercial Organic Analysis. By A. H. Allen. Vol. I., note to p. 305.

† Kreasote consists of a mixture of guaiacol $C_7H_8O_2$, and Creasol $C_8H_{10}O_2$, while phenol is C^6H^6O. Vide *Brauninger*. Jour. Lond. Chem. Soc., 1878, p. ii. 146.

‡ *T. Morson*, Jour. de Pharm. et de Chem., Dec., 1872.

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3. The effects produced by addition of a few drops of ferric chloride to their aqueous solutions. Kreasote gives a brownish yellow coloration while phenol gives a bluish violet.*

Fluckiger† tests for the presence of phenol in kreasote by warming a water solution of the sample with one fourth its volume of ammonia hydrate, wetting the inside of a porcelain dish with this solution, and then blowing fumes of bromine upon the surface of the dish. In presence of phenol a fine blue color appears. Kreasote gives only a dirty green or brown. The test requires care to avoid excess of bromine which spoils the reaction.

Still another test is that with a splinter of pine wood‡ which is first dipped in a water solution of the sample, and then in concentrated hydrochloric acid. In the course of half an hour the wood assumes a bluish color if carbolic acid were present.—At least such is the statement, but it has been found that concentrated hydrochloric acid alone will produce this effect, and the test has been abandoned as untrustworthy.

With regard to tests for phenol, independent of comparison with kreasote, various test have been proposed or used. The principle ones are as follows:

Ammonia and Hypochlorite.§ On adding to a water solution of phenol about one quarter its volume of ammonia hydrate, and then a solution of bleaching powder or some hypochlorite, a fine bluish green coloration develops—rapidly, if heat is applied.‖ This is said to detect one part of phenol in 3,000. The reaction has been used per contra as a test for ammonia and for that purpose is tolerably delicate.

* Vid *Böttger* Pharm. Centralhalle xvii, 284.

† Arch der Pharm. cciii. 30.

‡ U. S. Dispensatory, 13th ed. p. 342.

§ *R. Lex.* Berichte der Deutschen Chem. Gesell, iii. 457. *Cotton*, Bull Soc Chim de Paris, xxi. No. 1. *Salkowski.* Archiv der Physiol., v 353.

‖ Vid. *Jacquemin* Archiv der Pharm. cciii. 47. Anilin with hypochlorite used.

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*Nitric acid.** The addition of nitric acid to a solution containg phenol gives (especially on warming) a yellow coloration due to the formation of picric (trinitrophenic) acid.

One part of phenol in 6,000 may thus be detected, but as nitric acid yields picric acid or other compounds having a yellow color, with various organic substances, the test cannot be considered as very distinctive.

Mercury nitrates.† Millons reagent, etc. Solutions of mercury in nitric acid, affording mercurous or mercuric nitrates (one or both) containing some nitrous acid, have been proposed by different experimenters. Millon's reagent is a solution of mercury in fuming nitric acid. The addition of a solution of this kind to a water solution of phenol gives in a short time a strong blood red tint resembling the reaction of sulphocyanides with ferric salts. The reaction is hastened by the application of heat. The reaction is said to perceptible when only one part of phenol in 200,000 is present.

Concentrated Sulphuric acid.‡ On pouring a solution containing phenol upon the surface of concentrated sulphuric acid in such a way that the liquids do not mlx, the zone between them takes a greenish or bluish tint, becoming finally red. One part in 2,000 is said to be perceptible by this test. The colors however are very delicate, and take some time to develop. Since different intensities of tint may be obtained with different qualities of sulphuric acid, the reaction may possibly be due to some impurities in the acid perhaps nitrogen oxides.

Molybdic acid in concentrated Sulphuric acid.§ The ad-

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* *Pollacci.* Gaz. Chim. Ital. iv. 8.

† *Plugge.* Fres. Zts. f. anal Chem., xi. 173. *Fluckiger.* Archiv d. Pharm., cciii. 30. *Poehl.* Pharm. Zts f. Russland, xvi. 547.

‡ *Pollacci.* Gaz. Chim. Ital., iv. 8.

§ *Davy.* Polyt Notiz bltt, 1878. 300. Vid. *Fröhde* Zts. Allg. Oesterr. Apotheker-verein, Sept. 20, '73.

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dition of conc sulphuric acid containing ten per cent. of molybdic acid in solution, to a solution of phenol gives at first a bluish tint, which in a short time passes to reddish violet. The test is best performed in a white porcelain dish. The reaction is said to serve for the detection of small amounts of phenol in kreasote.

*Potassic dichromate with concentrated sulphuric acid.** Pollacci highly recommends this test which is performed in a similar manner to the last. The coloration produced is brown. The delicacy of the test is put at one part in 3000. The coloration is apparently due to the partial reduction of the chromic anhydride formed, and it might be anticipated that other organic compounds would give the same or a similar reaction. The test is but little used.†

Euchlorine test.‡ This is thus described:

In a five inch test tube put ten grains powdered potassium chlorate, pour on concentrated hydrochloric acid to the depth of one inch; allow the evolution of gas to proceed for half a minute. Dilute with one and a-half volumes of water, and remove the gas by blowing through a bent tube. Pour in ammonia so as to form a layer on the top. Blow out the ammonium chloride fumes, and add a few drops of the sample. In the presence of phenol, the ammonia layer assumes a rose red, blood red, red brown or dark brown tint, according to the amount of phenol present. One part in 12,000 gives the reaction.

Ferric Chloride.—The addition of ferric chloride to a solution containing phenol gives a fine bluish violet coloration. The reaction is materially interfered with by the presence of acids or neutral salts, and with water solution from crude samples it alters rapidly; usually to a dirty greenish hue.

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* Ber. D. chem. Gesell, vii 360. Gaz. Chim. Ital. iv, 8.

† Tasca Lanza, Gaz. Chim. Ital. iv.

‡ *C. Rice.* Am. Jour. Pharm, Mar. 1873, p. 98.

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*Bromine Water.**—This test is readily applied. The addition of bromine water to a solution containing phenol gives a whitish curdy precipitate of tribromphenol which redissolves in the solution of phenol when but little of the bromine water has been added; a further addition renders the precipitate permanent. The delicacy of this test is one part in 43700 (Landolt,) one in 15500 (Polacci† and Locatelli.) The precipitate is soluble in ether, alcohol, carbon disulphide, and the most of that class of solvents, as well as in alkaline solutions. The homologues of phenol, as well as aniline, toluidine, quinine, morphine, etc., give a similar precipitate. In contact with sodium amalgam the tribromphenol is reconverted into phenol which may be recognized by its odor.

The chinchona alkaloids have also been proposed as tests for phenol.‡

The odor of phenol is said to be perceptible to the extent of one part in 2800.§

As quantitative tests for phenol the degree of solubility of a sample in water or in alkaline solutions,‖ and the ferric chloride ¶ test have been used until quite recently. The two first methods consist in simply shaking up a measured amount of the sample with sufficient water or alkaline solution to dissolve it, were it all phenol, and measuring the amount of oil undissolved.

With pure water there exists the practical difficulty that the insoluble portion will partly rise to the top, partly sink to the bottom, and part again stick to the sides.

* *Landolt.* Ber. D Chem. Ges. iv. 770.

† Gaz. Chim. Ital., iv. 8.

‡ *Hesse* Liebigs Ann. Chem. clxxxi. Heft 1.

§ *Landolt* loc cit.

For comparison of the relative delicacy of these different tests see *Landolt* loc cit. *Pollacci* loc cit, and *Almen* Archiv der Pharm. vii. 44.

‖ *Ott.* Dingl Polyt. Journ. clxxxvi. 148. See also *H. Mulier* Zts. f. Chem. N. F. i. pp. 271 et. seq. *H. Hager* Pharm. Central Halle, 1872, no. 5.

¶ *Leube* Wittsteins Vierteljahresschrift f. Pharm. xx. 574. Dingl. Polyt. Jour. ccii

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Acting on Prof. Chandler's suggestion, I have used a measured quantity of olive oil with the sample, which will mix with the impurities, and in this way tolerably good results may be obtained. The oil, however, should not be added until the sample has been thoroughly shaken up with the water, since otherwise it will hold back some of the phenol, and prevent its solution in the water. Making the test with a solution of a fixed alkali presents fewer difficulties, but some of the impurities which are not phenol will also dissolve in the alkaline solution and give too high results. In either case the results are usually too high, since the crude phenol may hold a considerable quantity of water, which by this method is reckoned as phenol.

The ferric chloride test is a colorimetric test, and is performed by making a solution of the sample (10 gms in 1 litre, for instance) filtering to clear it, and then comparing the color obtained in 10 c.c. of this solution by the addition of two or three drops of ferric chloride, with the color obtained in solutions of phenol of known strength, with the same amount of that reagent. The difficulty with the test is that solutions of the crude samples often afford a very different color from that obtained with pure phenol, and moreover, in almost all cases the color alters so rapidly as to give great difficulty in making a satisfactory estimation. Moreover, the test cannot be applied in testing carbolates of lime or similar preparations.

Taking the reaction described by Landolt (the precipitation of phenol by bromine) I have succeeded in obtaining what I believe to be a reliable method for the quantitative estimation of phenol. The results were obtained in 1873, and published the next year, not, however, in what I have heard called "the current of chemical literature," so that processes based upon this reaction have since been published * which has given the authors the claim of priority

* *Koppescharr.* Fres Zts. f. ana'yt chem , xv., 233. *Degener.* Journ. f. Prakt. Chem., N. F., xvii , 390.

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in the matter. The method which I use is, however, somewhat simpler than the others.

The solutions necessary are :

1. A solution of ten grammes pure crystalized phenol in one litre of water. This solution serves as the standard with which to compare the results obtained on the samples analyzed. The solution will keep for some months without alteration.

2. Solution of bromine in water. In practice it has been found convenient to keep on hand two bottles, one with the bromine in the bottom, the other for the solution when it becomes sufficiently saturated.

3. Solution of alum in diluted sulphuric acid. Diluted sulphuric acid containing about 100 c.c. conc. sulphuric acid in the liter is shaken with alum crystals until saturated.

The use of this solution is to aid in the ready separation of the bromine precipitate, by making it more dense, and by insuring the necessary acidity of the solution. The sulphuric acid also holds more alum in solution than pure water which is an advantage. This solution is not absolutely indispensable, but in using it the analysis usually works more smoothly.

The process is conducted as follows: 10 grammes of the sample are weighed out and then run into a liter flask, water added, and the mixture shaken, the flask being finally filled up to the mark. After through mixing, some of the solution is filtered through a dry filter, and 10 c.c. of the clear solution is run into a six, or eight oz. reagent bottle, fitted with tight fitting glass stopper, about 30 c.c. of the alum solution is added, and in a similar bottle 5 or 10 c.c. of the standard phenol solution are placed, also with about 30 c.c. of the alum solution. A burette is now filled with the solution of bromine, and from this the reagent is run into the bottle containing the standard solution of phenol until no more precipitate forms. The bottle must be stoppered and shaken after the addition of every few c.c. Toward the

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end of the reaction the precipitate forms rather slowly, and when the phenol has been saturated a very slight excess of bromine gives a yellow tint to the solution. Shaking the bottle causes the precipitate to separate readily, leaving the solution clear. The bromine water is usually taken of such a strength that about 30 c.c. are required to precipitate the phenol from 10 c.c. of the standard solution.

The solution from the sample is treated in the same way, and from the amount of bromine water required for each respectively, the percentage in the sample may be readily calculated. E.g. If 5 c.c. of the standard, required 15 c.c. bromine water, and 10 c.c. of solution of the sample took 17 c.c., the calculation would be

$$(15 \times 2) : 17 = 100 : x \text{ per cent.}$$

If, in weighing out, 10.25 gms. instead of 10. gms. had been taken, this result would have to be divided by 1.025 to get the true percentage.

As the precipitate rises to the top instead of settling to the bottom, it will be found convenient to use a small glass tube, a little longer than the bottle and flared at the top in funnel form, through which the bromine may be introduced into the clear solution. The bromine water held in the tube by capillary attraction, can be gently blown into the solution without inconvenience to the operator.

With most of the samples of commercial phenol "carbolic acid" the precipitate will not readily separate from the solution even by prolonged shaking. The solution may be at once cleared, however, by adding to it some of the precipitate already obtained by testing the standard phenol solution and shaking up.

The end reaction is when the further addition of bromine water fails to produce any precipitate. With pure phenol the solution only assumes a yellow color when an excess of the bromine is present, but with many of the commercial samples the solution has a yellow tint from the start, which, however, does not appear to deepen until the phenol or its homolo-

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gues are saturated. The effect of the bromine upon the homologues of phenol as cresol, phlorol, etc., is probably the same, and in conducting an analysis by this method, those substances are reckoned as phenol. The absence of aniline, toluidine and similar bases which may be present in the coal tar should be insured, as those bases also react in a similar manner with the bromine water. Usually the mode of preparing the commercial carbolic acid by means of alkaline solutions precludes this source of error, with a dead oil, however, the sample requires a preliminary treatment with solution of some fixed alkali to remove them.

The bromine water does not of course keep the same standard throughout, but during a morning's work it varies very little. Until the solutions gets low in the bottle, every other burette full seldom gives a variation greater than 0. 1 to 0.2 c.c. on 10 c.c. of standard phenol solution. Unless the bromine water is allowed to stand in the burette for sometime, the last portions have the same standard as the first.

The other quantitative methods using this reaction with bromine are somewhat more elaborate, an excess of bromine water being used, and the excess being titred with sodium hyposulphite or detected by iodized starch paper. A stronger solution of bromine also is used, and the methods, though the same in principle, are quite different in detail.

PRECIOUS STONES.

BY H. T. VULTÉ.

PART I.

By this term we include all minerals which from their beauty and extreme rarity, rather than any useful properties, are much esteemed by men for purposes of adornment.

To trace the history of gems would be a very tedious,

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though perhaps interesting, subject, and in this short article I shall have space only to give a brief outline of their history in general.

In the most ancient Egyptian ruins gems having scarabei engraved on them have been found, but the first authentic account appears in the Bible, where a description of the breast-plate of the High Priest is given. This breast-plate was ornamented with twelve stones, as follows: the Sard, Topaz, Ruby, Emerald, Sapphire, Diamond, Turquoise, Agate, Amethyst, Beryl, Onyx, and Jasper, each having its own peculiar signification. It may be taken for granted that these stones were the same as those which now bear their names. In common with other ancient nations, the Hebrews possessed superstitious ideas regarding gems, and the similarity of belief seems to point to the fact of their having been articles of commerce to a greater or less degree. Fragments of these superstitions remain even to this day in regard to the pearl, and more especially the opal, which is supposed to bring grief and misfortune to its unlucky possessor. A quaint little story is told, with perfect gravity, by one of the old Spanish writers. A rich old Spaniard possessed a pearl of great beauty and value; one of his friends admired the stone very much and sought to buy it, but did not succeed; at last the old man fell sick and died, and his friend was about to buy it at the sale of his effects, but was deterred from purchasing by observing that the stone was dull and apparently valueless, so he allowed some one else to secure it at a very low price. When in the possession of its new purchaser the stone is said to have regained all its pristine beauty and brilliancy. This little anecdote will serve to show the superstition regarding these stones even at a comparatively recent date.

We know that the Greeks and Romans were possessed of and valued gems, as Pliny and Dioscorides, as well as many other ancient writers, have fully described the most

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important ones, such as the diamond, ruby, emerald, etc. It is hardly worth while, in this short paper, to trace down their history from this point, but it is well to mention that since the discovery of America, diamonds and emeralds have become more common, though hardly less valuable.

It must, moreover, be held in mind that these minerals possessing such value and beauty, are rare when compared with other minerals, for of the many found only a very limited number are fit for cutting.

Before entering into their discussion in detail, I will classify the gems so that they may be taken up in logical order. For this purpose, it seems best to me to divide them into two classes, according to their known origin:

FIRST.—MINERAL.—Diamond, Corundum, Chrysoberyl, Spinel, Topaz, Beryl, Zircon, Garnet, Tourmaline, Quartz, Tourquoise, and Opal. SECOND.—ORGANIC.—Pearl, Coral, and Amber.

Diamond.—The diamond, king of jewels, seems to have been known in the most remote ages of which we have any authentic account. The ancients, however, did not possess any means of cutting and polishing the stones, and only those which retained their crystalline form were made use of.

The first mines worked were those of British India, which are now almost, if not quite exhausted, but so rich were they that even in the latter part of the 17th century, they furnished the major part of all the diamonds found. It is said that the Sultan Mahmoud, Rajah of Deccan, who lived about 1177 A.D., left in his treasury, after a reign of 32 years, more than 400 lbs. weight of diamonds. In 1727 the Brazilian fields at Minas Gaeraes, were opened, and since then have furnished about two tons of diamonds. These mines were first worked for gold, but when diamonds were found, no account of the gold was taken. Other localities which furnish the stone are Sumatra, Java, Borneo, Ural Mountains, South Africa, and Australia. In this

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country diamonds have been found in North Carolina, Virginia, California, and Idaho.

Geology.—Diamonds occur in metamorphic sand-stones which carry magnetic iron, gold and platinum, also in alluvium. In the first case they are generally found as crystals, octahedra and dodecahedra, in the latter as rounded pebbles or shattered crystals. The reason for this is obvious; in the first case they probably were formed by the decomposition of hydrocarbons under great pressure, although there is no evidence of any great heat, and were not disturbed, in the second case the stones have been washed out of the rocks and carried down into the valleys along with the other metals, and errosion and grinding have worn off the sharp angles. This latter and most commonly occurring deposit is a sort of placer, which goes by the general name of *Cascalho* in Brazil, and may be divided into four groups: *Grupiara*, alluvial deposits, the bed of an ancient river; *Burgalbas*, small angular rocks, strewing the ground; *Cascalho* proper, fragments of rock and sand, mixed with clay, forming the bed of an existing river; *Takoa Carza*, sand, clay, and rock, conglomerate.

To Bernhardo Fonseca Lobo is due the honor of discovering diamonds in Brazil. He recognized the stones as similar to those which he had seen in the Indian mines, and carried some to Lisbon, where they were tested and found to be the true gems.

The government, hearing of the discoveries, took possession of the mines and drove off all who worked on their own account, but after a dreadful drought and earthquake they relented and allowed the original possessor to return. This was May 13th, 1803. The mode of washing is as follows; in the dry season which lasts from May to October the rivers are very low, the water is then turned from its channel and the river bottom dug up to the depth of 10 or 12 feet and deposited in heaps near the factories. At the close of the dry season the alluvium is dealt out to slaves who place

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about 100 lbs. in a trough called a canoe, and cradle it with water, as in the gold washing process. When the water runs off clear they examine the pebbles, one by one. If a slave finds a stone of 18 carats weight, which is a rare occurrence, he is set free, and a present made to him.

The rough stones are classified into: *First.—Diamonds*, or those stones which are of use as jewels, and in the arts. *Second.—Carbonate* or *Boart*, an imperfectly crystallized diamond of granular structure, and of a brownish green color, used as a powder to polish diamonds and other gems.

Diamonds in their rough state show very little of their fine quality, and in order to render them fit for use as gems, it is necessary to cut and polish them. To Louis Van Berghan, of Bruges, is due the honor of cutting the first diamond in a scientific manner, so that all its latent beauties were made manifest. This he accomplished in the year 1456. Sometime afterwards he established a guild of diamond cutters. Religious intolerance, in after years, drove the cutters to Amsterdam where, up to within a very few years, the best work has been done, and in fact 15-16 of the diamonds cut. But within the last few years one of our inventive fellow-townsmen has devised a machine for cutting diamonds which does its work more accurately and rapidly than the Amsterdam diamond cutters can ever hope to do.

Cutting.—Cutting accomplishes two things, it fashions the stone into a regular shape and brings out the lustre and fire. Owing to the fact that the diamond has an easy cleavage parallel to the octahedron the rough stone is first chipped off into this shape, provided it is not a very large one. This is accomplished by fastening the stone to the end of a stick as in the method for cutting. A scratch is then made along the line of cleavage. The stick is then placed vertically in a leaden socket, a fine sharp knife inserted in the scratch and the chip split off by a smart blow from a hammer. When this chipping has brought the stone into a shape somewhat similar to that desired, it is cemented on the end

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of a stick. Two stones thus prepared are then rubbed together until a flat, even surface is produced; this is called a facet. The dust which falls is caught in a box containing oil and used for cutting another surface. The stones are then taken out of the cement, and placed in another position, and other facets made. By this operation only a general outline of the form is made. A stone which has 52 faces when complete receives only 18 in cutting.

Polishing.—By this process the diamond is not only polished, but the remaining facets made. This is done on a steel disc called a "skaif," by means of diamond powder, the disc revolving at a high rate of speed by steam or water power. The surface of the skaif is prepared by rubbing with an ordinary whetstone, forming tangents of a circle whose diameter is about one-third that of the skaif; by this means the surface of the skaif is scratched. Then a fine hone is rubbed over the disc in the direction of the diameters until the scratches are almost obliterated; thus a surface is made capable of receiving and retaining the powder which is spread on the skaif with olive oil and the flat surface of a diamond held against it until the powder is forced into the disc. The diamond to be polished is fitted into a brass handle, fastened with solder, and held against the wheel until the facet is made. It is then reset to receive another facet. This work requires the most skillful workmen, as any wrong move may utterly ruin a very fine gem; and when we consider how small the facet may become, when small stones are to be cut, it is easy to see what great care must be taken. The forms in which the diamond is cut are as follows: Brilliant, single, and double; Rose, Table, Briollets, and Cabochon.

Properties.—Specific gravity 3.55. Hardness 10. Infusible, insoluble. Crystallizes in octahedra and dodecahedra. The cleavage is perfect and parallel to the octahedron. The fracture is conchoidal. It is simple refracting and transparent, or translucent, and composed of pure carbon.

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Its colors are white, green, blue, and red, varying in intensity to black. The index of refraction is 2.455, nearly double that of glass; and its dispersive power is also great, and to this is due that peculiar property so appropriately called fire.

The weight caret, used in speaking of all gems, is derived from the East. In the middle ages the standard of weight for this purpose was a bean, which possessed a singularly regular weight, and was known in Arabia as the Karat. The value of the carat is now placed at 25 milligrams. It is difficult to lay down any rule by which diamonds can be accurately valued. The English rule, as used in 1865, rated a one-carat stone of the first water, and cut as a brilliant, at £21 sterling. For stones between 1 and 6 carats the rule is to multiply the square of the weight by £21.

A diamond of the first water must have no flaws, or specks, possess a good and symmetrical shape, brilliant fire, and be of a clear white or bluish white color; the slightest shade of green or yellow detracts greatly from its value. If, however, these tints deepen to a decided shade, the stone acquires a fancy value. By experience one may easily learn to judge of good stones, and it is not a difficult matter for the experienced jeweler to detect a bogus or paste stone.

The following is a list of the most celebrated stones: Braganza, 1880 carats, said to be a white topaz; Rajah, 367; carats; Koh-i-noor, 186; Florentine (yellow), 139½; Regent, 136¾; Star of the South, 125¼; Shah, 95; Piggott, 82¼; Saucy, 53½; Dresden (green), 48½; Hope (blue), 44½; Russian (red), 10.

Corundum.—Next to the diamond in beauty and value, is the Corundum, the various colors of which are familiar under the names of Oriental Ruby, Emerald, Topaz, Sapphire and Amethyst, all having the same composition and properties, so they may be considered as one general class. The name, Corundum, is derived from Korund, a sanscrit

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word meaning hard, and has been given to those massive varieties which are known generally as emery. Count de Bournon in 1802, classified the corundums, giving to the colored transparent varieties their names of Ruby, etc. These stones have been known and appreciated from remote antiquity, and are all mentioned in the Bible.

Properties.—Hardness, 9. Infusible, insoluble. Crystallizes in rhombohedra. The fracture is conchoidal, streak white, lustre vitreous. May be transparent or translucent. The specific gravity is from 3,909 to 4.16. Composition Al. 53. 4 per cent., O, 46.6 per cent. It is electrified by friction, and remains so for some time, and doubly refracts, the index being 1.765.

Ruby.—The true Ruby has a pigeon blood red color and is found associated with Gold, Sapphires, Zircons, Spinels, Stream Tin, Magnetite, Rutile, Topaz, etc., in earthy strata, or beds of rivers, but never in the solid rock. The finest stones come from Ava in Siam, in the Capelan Mountains in Ceylon, Brazil and India. In Siam they are found in stratified deposits from two to thirty feet below the surface of the ground. In Ceylon, they occur in the beds of streams.

The Ruby has been made artificially by heating pure alumina with borax in a platinum crucible, the alumina fuses and on continuing the heat the borax is volatilized, leaving crystallized alumina which occurs, however, in such small and irregular shapes as to be practically useless for jewelry purposes.

Rubies are cut on a skaif with diamond powder, and polished on copper plates with tripoli and water. The best form of cutting is a mixed brilliant in which the top of the stone is cut as a brilliant, and the lower part is step-cut ; but if the stone be silky, it shows better when cut en cabochon. A six-pointed star may often be seen in Rubies and Sapphires by looking across the crystals. This peculiar formation is probably due to imperfect crystallization and adds greatly to the beauty and value of the gem.

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The value of a perfect Ruby exceeds that of any other stone, and for this reason red minerals such as spinel or balas ruby, carbuncle or deep red garnet are used to counterfeit the ruby. Red tourmaline is also sometimes used for this purpose. A ruby of one carat is valued at from £14 to £20.

Sapphire, or blue variety. The most valuable are those which possess the bleu du Roi color. Frequently the stone receives its color from a speck in the interior which is made the culet in cutting. In the night, such stones have a deeper color and greater brilliancy than those colored throughout.

The ancient writers speak very vaguely of the Sapphire, for this term seems to have included all blue stones, even lapis lazuli was called sapphires. Many quaint virtues were imputed to the stone. A few are as follows: the prevention of evil and impure thoughts; that it is an enemy to poison, for if put into a glass with a spider or any venemous reptile it was believed it would kill it.

The value of a clear, evenly spread, deep blue sapphire of the same color by night and day, and weighing one carat, is £20, it does not, however, increase very considerably with the weight, as one of 100 carats would probably be worth in the neighborhood of $10,000.

The following varieties of corundum are rarely met with in jewelry, with the exception of the topaz.

Oriental Amethyst, a ruby or sapphire possessing the color of an amethyst, but much more brilliant and lively than its quartzose namesake. There are a few fine specimens in Dresden, also in the Vatican. No rule of valuation can be made for this stone.

Emerald, rarest of all gems. It is similar to the beryl emerald, but has a finer lustre.

Topaz is of little value in jewelry, as it is so light in color as often to be confounded with the yellow diamond.

Chrysoberyl, also called oriental chrysolite, is a brilliant

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yellowish green gem sometimes possessing an opalescence, when it is called chrysoberyl cat's-eye, or cymophane. Chrysoberyl crystallizes in a right rhombic prism of 129° 38′, its lustre is vitreous, and fracture conchoidal. It is transparent or translucent, and sometimes opaque. Infusible and insoluble; hardness 8.5; gravity, 3.5-3.8. Its composition is Al_2O_3, 80.2 per cent.; Be_2O_3, 19.8 per cent. Chrysoberyl is found in Brazil and Ceylon as rolled pebbles, in the United States at Haddam, Ct., and Greenfield, N. Y. In Ceylon it is in alluvial deposits of rivers at Saffragang, and imbedded in mica slate in the river Tajowaja in the Ural Mountains. Transparent yellow chrysoberyls are cut in brilliant, but are rarely used. Semi-transparent stones are cat's-eyes. The value of the transparent varieties is only nominal, the cymophanes, however, bring very high prices, and have lately come into fashion. As much as $5,000 has been paid for a fine one. Ordinary stones range from $500 to $2,000.

Spinel.— Under this general term are included balas ruby, rubicelle, spinel ruby, plamandine ruby, all of which are red. The black opaque varieties are ceylonite, green chloro-spinel, sapphirine blue, dyshnite, hercenite, etc.

Spinel Ruby—Is of a fine cinnamon red color, easily distinguishable from the true ruby, being far less brilliant. This stone comes from Ceylon, Mysore, and other Eastern countries, where it occurs in alluvial deposits, as rolled pebbles.

Sapphirine is found in Sweden.

Chloro-spinel in the Ural Mountains.

Ceylonite in Ceylon.

Spinels belong to the Isometric system, generally occurring in octahedra. Their fracture is conchoidal, lustre vitreous. They are transparent, translucent or opaque. Their colors range from blue to red. Hardness, 8; gravity, 3.5-4.9; composition Al_2O_3, 72 per cent; MgO, 28 per cent. Infusible, but change color when heated. Difficultly soluble in sulphuric acid. Simple refracting.

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Spinels are cut on an iron wheel with emery or diamond powder and polished on a copper wheel. The form is a mixed cut. Their value ranges from 10*s* to £8 per carat.

The Topaz, so fashionable fifty years ago, cannot be readily bought at the present day. It rarely occurs of any great size free from imperfections, and most of the large so-called topaz were yellow quartz or cairngorm.

Topaz crystallizes in right-rhombic prisms of 124.17°, having an easy cleavage parallel to the base, a conchoidal fracture and a vitreous lustre. It is transparent or translucent, and sometimes opaque specimens are found. It varies in color through yellow, blue and green, and has a colorless streak. Hardness, 4; specific gravity, 3.4–3.65; composition Si, 15.17; Al, 29.58; O, 34.67; H, 28.58. It is infusible, but when heated, yellow varieties become pink and are then known as "Burnt Topaz." It is partially attacked by sulphuric acid.

Topaz occurs all over the world in granite and gneiss rocks containing fluor spar, but the best stones come from Brazil and Saxony. They are cut on lead wheels with emery, and polished with tripoli. The form is full brilliant. It is impossible to fix any rate of valuation for the topaz.

Nebular masses are often seen in topaz, which consist of small cavities in the stone filled with a very volatile hydrocarbon, and from this circumstance it is concluded that the stones were formed at a low temperature and under great pressure.

Beryl.—There are two kinds: first, *Emerald*, the green, transparent variety; second, *Aquamarine*, the light blue, or sea green variety. They belong to the hexagonal system, and have like properties, the only difference being that the emerald contains a little more glucina than the aquamarine. Their fracture is conchoidal. Gravity, 2.67 to 2.75; hardness, 7.5 to 8; lustre vitreous; streak white; insoluble, and infusible, transparent, and green, though the color sometimes changes to brown. The emerald is very brittle, which renders

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it difficult to cut. On first being taken from the mine, it is very soft, but hardens by exposure to the air. The color of the emerald is due to organic matter which it contains, said by Mr. Lewey to be a hydrocarbon similar to chlorophylle, the coloring matter of plants. That its color is due to organic matter, and not to chromium, as some chemists contend, may be shown by heating a dark green emerald, which will then lose color and become perfectly white, while the green garnet, which contains chromium, does not change its color at any temperature. It is also highly probable that the stone is formed by deposition from chemical solution. The finest emeralds are mined at Santa Fe de Bogota, New Grenada, occurring in limestone rock frequently bituminous and fossiliferous.

Emeralds were well known to the ancients. In Egypt ancient mines have been discovered, the large galleries of which bear marks of tools, and the remains of ancient appliances, levers, etc., have been found there. Pliny relates that on the Island of Cyprus, on the tomb of Hermias, was a sculptured lion, with emerald eyes so bright that they frightened away the fish.

In the Middle Ages the stone was much used in church decoration in cups and chalices. At the conquest of Peru, emeralds became very abundant, and many hundred weight were sent to Spain by Pizarro.

The ancients ascribed the stone to Mercury, thinking it a pledge of good eyesight, and when taken in six grain doses, it was good for various diseases.

The Emerald nearly always contains flaws, hence it is difficult to set any exact rule of valuation. It is, however, next in value to the ruby, and when clear, perfect and of a good color is worth from $100 to $200 per carat. The light shades are much less valuable than the dark. The stone is cut on a copper wheel with emery, and polished on a tin wheel with rotten stone. It is most often cut in trap shape, but if flawed, as a brilliant with rounded tables which conceals the flaw.

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Aquamarine is more generally diffused than the emerald. It is found in Scotland, Ireland, France, Sweden, Germany, Brazil and Hindoostan. An enormous beryl weighing 2900 pounds was found at Grafton, N. H.

The value of aquamarine is trifling; it is used only for the cheaper kinds of jewel work.

Zircon, or Hyacinth, crystalizes in a right square prism, the cleavage of which is parallel to the prism and octahedron. The fracture is conchoidal and uneven. Gravity, 4. to 4.7; hardness, 7.5; lustre vitreous; streak colorless. It is opaque or transparent. When heated the stone becomes phosphorescent and loses its color. It is colorless, or varies from red to yellowish green. Insoluble, infusible. Its composition is Zircon 67 per cent.; SiO_2, 33 per cent.

Zircon is found imbedded in granite, syenite, gneiss and in alluvial river formations in Ceylon. When the stone is grayish or smoky white it is called Targoon. The zircon is found abundantly in our vicinity in small crystals of a deep red color occurring in magnetite. It was known to the ancients, and was called tachyleth in the Bible. Its value is purely arbitrary, being very little used in jewelry. A fine specimen, however, brings a good price. Targoon is cut in rose-form, the Hyacinth as brilliant, with rounded table.

Garnet is of a brilliant color and is much used in jewelry, under various names, according to the color, which varies with the composition. An abundant supply renders the garnet cheap, but nevertheless it is very highly thought of as a gem.

The different varieties have some properties in common. They are all of the Isometric system, occurring as rhombic dodecahedra, and trigonal trisoctahedra, whose cleavage is dodecahedral, fracture subconchoidal and streak colorless. Gravity, 3.15 to 4; hardness, 6.5 to 7.5; lustre vitreous. They occur of many colors, varying from colorless to red, brown and green.

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They are found in alluvial soil in India, Pequ, Ceylon, Brazil, and America. They are cut on copper with emery, and polished on lead. When cut in cabochon they are called carbuncle.

Common garnet is very abundant in this country in mica, slates and schists. It may be used in powder for polishing other gems.

Garnet was known to the ancients, being mentioned by Pliny. The superstitions regarding it are similar to those of the ruby.

Tourmaline is very little used in jewelry. It occurs of many varieties, the only one ever used is of an olive green tint. It crystallizes in rhombohedra. The fracture is conchoidal and uneven; gravity, 3.32; hardness, 7–7.5; lustre, vitreous; streak, colorless. It is insoluble and infusible. Transparent or translucent and opaque. Double refracting and pyro-electric.

The red variety found in Ceylon, Ava and Siberia is known as Indicolite.

Tourmaline may be cut on lead or zinc with emery and polished with tripoli. The transparent varieties are generally trap cut. The stone is transparent in only one direction, that is, across the axis.

NOTES ON THE BETHNAL GREEN MUSEUM, LONDON.

BY F. T. ASCHMANN.

During a short stay made last summer in London, my time was mostly employed in visiting the various museums for which that great metropolis is so justly celebrated. They all contain, to a greater or less extent, many objects and illustrations of various processes of interest to the chemist, and months might be profitably spent in studying them,

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Of all the collections which I visited, I found none more interesting than the Bethnal Green Museum, a branch of the South Kensington. Being intended especially for the benefit of the poorer class, it is situated in a somewhat out-of-the-way portion of the city, and is therefore rarely visited by tourists or even by the better class of Londoners themselves. I will endeavor to show you, however, that it is well worthy of a visit on the part of all desiring information.

The museum, a handsome red brick building, is situated in Victoria Square, and was opened in 1872. A part of it, especially the upper galleries, is devoted to loan collections of various kinds, principally of Art objects. The rest, comprising the first floor and the basement, is occupied by permanent collections, of which the most important are of specimens of food, of animal and vegetable products, of practical entomology, and of the utilization of waste products.

The Food Collection owes its origin, in 1857, to Thomas Twining, Esq., and has since then been perfected by various chemists, among others the late Dr. Lankester.

The foundation of the Animal and Vegetable Product Collection was laid in 1851, at the end of the Great Exhibition, when all the material from the various countries was united as far as possible. These collections are all arranged in a very popular way, and numerous labels and full descriptions accompany the specimens.

During the day and a half I spent at the museum, I was able to take many interesting notes, and will endeavor to give an idea of the various things to be seen. Of course these can only be passed in rapid review, most attention being given to those with which we are least familiar.

On entering the museum and turning to the left, we have before us the Food Collection. First we notice a large assortment of grains and legumins—wheat, barley, oats, rice, millet, maize, peas, beans, and lentils being largely repre-

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sented. Among others of curious shape and different sizes are the black beans, or "friziles," the principal food of the natives of Central America and Yucatan, who make a kind of flour from them. Peas, grown from seed said to have been found in an ancient Egyptian monument, are shown, as are also various varieties of the chick pea (Cicer arietium). These are used especially in Spain, and in the East. They are prepared generally by parching. "Parched peas are as common in the shops of Eastern countries as biscuits are in Europe." Under the head of Maize, or Indian Corn, I found one of those balls of pop-corn candy sold here quite frequently. It is evidently regarded as a great curiosity, for it carried the following label: "Poppe corn, prepared by heating grains of maize over a bright fire untill they burst. Is an important article of diet in the U. S." Next come the starch-producing plants and their products. The arrowroots are represented in great variety, as are also sago, tapioca, and rice starches. "Pithena" is the name given to a preparation from sago and potato starches. "Salep" is obtained from the orchis mascula of Arabia. Starches from the plantain, banana, chestnut, yam, sweet potato, canna, mandioc, and various other locally important plants, are shown. Very interesting are the cassava cakes, from West Africa. "These foo-foo cakes, as they are called, come from Sierra Leone, where the cassava is a very common article of food among the negroes who come from the Niger district. The balls consist of the grated root dried over the fire. In using them, they are rubbed down thoroughly, and then slowly stirred into boiling water until it becomes a thick dough—so thick, indeed, that it may be lifted bodily out of the pot—having the appearance of arrowroot, with innumerable particles of fibrous matter intermixed. It is eaten with palver sauce or pepper-pot, each mouthful being made into a ball, which is dipped half-way into the sauce." The preparations that may be obtained from the potato alone are very numerous, about thirty-five different ones being on exhibition.

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Bread in all its varieties is largely represented. "Pungapunga" is a New Zealand native bread made from the pollen of the Typha utilis. In times of scarcity, birch bark and even diatomaceous earth, the Bergmehl, was used for making bread; and in Paris, during the siege, the bread served out to the suffering inhabitants could not have been much better, to judge from a specimen exhibited. Cakes from Tuscany, made of chestnut flour, seem to be very nourishing. Subjoined is the analysis:

Water, - - -	14.	Sugar, - - - - - -	17.5
Flesh-formers, -	8.5	Fibres, chiefly cellulose,	3.5
Starch, - - -	31.	Mineral matter, - -	2.5
Dextrim, - -	23.		

As a historical curiosity, biscuits baked in commemoration of the jubilee of George III. are shown. Charcoal biscuits for dyspeptics, biscuits from sago, gluten biscuits, and biscuit powder are a few of the varieties.

Sugar from all parts of the world, from various sources, is here shown to perfection. The variety of products besides sugar furnished by the beet root is highly interesting, including as they do molasses, vinegar, empyreumatic oil, alcohol, salts of soda, potash and rubidium, residue for manure, cinders for making glass, exhausted pulp for making paper, etc. The sugars other than cane are:

Beet root sugar—Germany, France, etc. Millet sugar—Spain, Senegal, India. Cocoanut sugar—Ceylon, India. Date sugar—India. Maple sugar—America. Palm sugar—India, Java.

Preserved fruits, often very curious, and sugar confections of every kind, and from every country, are shown in great profusion. Rose-colored honey is produced by artificial feeding of the bees. Wild honey from India is quite black. On being fermented, honey furnishes the mead, or hydromel.

Butter and cheese are very important food products the world over. Glee, or Indian butter, is mostly made from

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the milk of the buffalo, while the Esquimaux prepare their cheese from the milk of the reindeer. The South American Indians make and extensively consume a gourd-shaped butter-cheese, the outside of which is built up of cheese, while the interior is filled in with butter. The Chinese prepare a kind of cheese from the pea and bean, which vegetables contain vegetable casein, or legumin. This legumin is extracted by boiling with water, and after precipitation with an acid and pressing, it is allowed to ripen, furnishing cheese. Dried curds from India, also rennet from the stomach of the camel are shown.

In this connection I may mention the Irish bog butter, of which a splendid specimen is on exhibition. This is a peculiar fatty or resinous body found at a considerable depth in the peat bogs in the West of Ireland. It is supposed by the common people of the district to have been ordinary butter, hidden away ages ago by the fairies, or hastily buried by smugglers. Even the label on the specimen at the Bethnal Green Museum says that, "through the action of water upon it for many centuries, this butter has been reduced to a mixture of palmitic, stearic, and oleic acids, the glycerine and cutyric acid having been almost completely removed." Mr. John Plant has shown it, however, to be a perfectly natural production, arising from the decomposition of the vegetable matters forming the peat, and belonging to the large family of mineral resins or hydro-carbon compounds.

The exhibit of the various alcoholic beverages is very extensive, and both interesting and instructive in many ways. In England wine is made from the grape in small quantities; from raisins; black, white, and red currants; gooseberries, raspberries, oranges, cherries, plums, elderberry, ginger, cowslip, etc. In fact, alcohol may be produced from almost anything, and a few of the most remarkable varieties of it are from peaches, Jerusalem artichokes, sugar, millet, locust bean, apricots, cider, etc.

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Liquors are also in great variety. Beer is, however, the great drink of England, and it is said that 3⅓ gallons of alcohol are consumed yearly by each person there in this form alone, while 1½ bushels of barley are necessary to produce that amount.

The other stimulants are in great abundance, and their study would fill a book of itself. I counted twenty-four substitutes for tea alone in the museum, while coffee and tobacco showed a corresponding amount, not to speak of the adulterations. These adulterations of the narcotics, as well as those of the spices, which are fully represented, are shown in a very extensive manner, and occupy several cases.

Insects are not eaten at all with us, the most important substance used as food which we obtain from them being honey. In many parts of the world, however, they are used to a greater or less extent. In the East and West Indies, and in Brazil, the natives eat the larvæ of beetles belonging to the genera Calandra and Passalium, the species of which feed on palm trees. The larva of the stag beetle is eaten in Rome, and the cockchafer is enjoyed as a tit-bit by the inhabitants of some parts of Europe. In Syria, Arabia, Egypt, and Abyssinia, various kinds of locusts (Gryllus) are eaten, and esteemed as a great luxury. The Bushmen of Africa, and the Indians of America, eat the so-called white ant. A species of the common ant (Farmica) is eaten in this country. The chrysalis and larvæ of butterflies and moths are relished in New Holland, California, and Peru, by the natives, whilst the larva of the silkworm is esteemed as a luxury in China. In the preparation of the latter, they are taken from the cocoons from which the silk has been unwound, and, after being roasted in an oven, are served up with soup. The chemistry of the insect kingdom has only been imperfectly investigated. It appears, however, that the flesh and the eggs of insects are composed of the same substances as those found in the higher animals.

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There are many other equally interesting food products which it would be interesting to discuss in detail, but which must be passed over. Such are the oil and fat producing plants and animals, the various nuts used all over the world, birds and mammals used as food, edible birds' eggs and nests, food products from China and Japan, etc.

I must, however, speak of an important feature of the collection which gives to it its popular character. This is a class of specimens which illustrates, by what may be termed *displayed analysis*, the chemical composition of many individual food materials. They are shown in several rows of cases, which are divided into compartments, each of the latter being devoted to the substance under consideration, such as meat, milk, potatoes, etc. To take an example. Let us suppose that the chemical composition of meat is to be displayed. A pound of it, represented in the case, on account of its perishability, by an excellent wax model, is first shown; then follow in convenient vessels the exact amount of the different constituents, such as water, fat, fibrin, salts, etc., to be found in the meat. As this same plan is followed with a great number of substances used as food, the collection allows of a very good comparison between them, and gives a very excellent idea of their chemical composition.

In conclusion, I may express the hope that since an exhibition here in 1883 is now assured, steps will be taken to collect and unite in a suitable building a collection similar to that in the Bethnal Green Museum, thus affording the inhabitants of New York an opportunity for improvement equal to that given to those of London at the end of their Great Exhibition in 1851.

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THE DOCKS OF NEW YORK.

BY WALTER M. MESEROLE.

The necessity of a proper system, under which all the dock improvements for a harbor shall be made, need scarcely be dwelt upon. A few instances where the lack of such a system, or a total disregard of its principles, has wrought much injury to commercial interests in the case of the harbor under consideration, will be all that can be needful to establish the necessity of a system adapted to the peculiar local circumstances, and supreme in its province.

The dockage of the city in Colonial times consisted of a number of slips, or narrow basins, irregularly disposed along the water-front, and separated by broad land spaces. Before the Revolution, the commerce of the city had grown to such proportions that, although the entire available water-front of the embryo city was occupied, more accommodation was needed, making a radical change imperative.

On the other hand, we have in the pier at West Thirteenth street, and Lorrber's Bulkhead on the East River, extending from Thirteenth to Eighteenth streets, notable examples of grasping speculation. The pier, projecting several hundred feet into the river at its narrowest point, is a serious obstacle, and has a very deleterious effect on the tidal currents, whose office it is to maintain, by their scouring properties, the channels at the entrance of the harbor. Lorrber's Bulkhead, in like manner, is a badly located structure, at a bend of the East River, and the abrupt narrowing of the river is the cause of bad eddies, which render navigation needlessly difficult.

The work of selecting a system of dockage for a harbor must be begun, of course, by a study of its natural characteristics. The form of the harbor of New York is familiar to all. The city lies on Manhattan Island and extends on the main land into Westchester County. The northern portions, as

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yet, are undeveloped for the purposes of trade, and an occasional pier for local needs is sufficient for the present; but all steps toward harbor improvement must have reference to the future developement of these localities, and nothing should be done to interfere with its progress.

On either side of the city we have the Hudson and East Rivers, the latter a crooked but valuable channel connecting with Long Island Sound, and the former a river navigable by large steamers for one hundred and fifty miles above the city, and an important member of the system of internal navigation afforded by the canals and the chain of Great Lakes, by means of which New York is made the most convenient point of export for the grain and other products of the West.

The shore line of the city consists of thirteen miles on the Hudson, nine and a-quarter on the East River, and two and a-half on the Harlem River, which, with the twelve miles secured by the late annexation, makes a total of thirty-six and three-quarter miles of water-front under the control of the city. Besides, there are the long reaches of water-front of Long Island, Staten Island, and of New Jersey, the interests of whose owners are most intimately connected with those of the city.

The two great rivers, with deep water and no obstructions, empty into the upper Bay, which affords fourteen acres of anchorage ground, while the lower Bay contains eighty-eight acres, well sheltered and provided with excellent holding ground. In general the water is deep close to the shore line, and the high grounds adjacent being always leveled off before dockage is demanded, the land approaches are easy. The shape of the island is such that a few longitudinal transportation lines can bring all points of the shore line into close communication. The mean rise of tide is 4.62 feet.

The general characteristics of the harbor being so different from those of most of the model harbors of the Old

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World, none of the expensive constructions necessary there are demanded in this case. No artificial protection from the sea being necessary, costly breakwaters are not called for, and the rise of the tide is so small that the construction of tidal basins would be an inexcusable extravagance.

The absence of these constructions from the port of New York makes it appear, by comparison, but poorly provided for, when, in fact, a very simple and inexpensive class of structure has been experimentally proven equal to all the demands of its commerce. This is the system of bulkheads and piers, which has always received the most attention in New York, and is conceded by all who have studied the problem to be the one best adapted to the circumstances of the case.

The only system besides this that has ever been tried in the harbor of New York, is the system of wet basins, which has proved very successful. The wet basins, as built in South Brooklyn, were formed by running out piers so as to nearly inclose areas of shallow water which were afterward deepened by dredging. Within these basins vessels may lie at the docks undisturbed by floating ice and rapid currents, and their cargoes may be easily protected from thieves. They are designed to be surrounded by storehouses, into which the cargoes may be carried directly from the vessels by elevators and other mechanical appliances. The construction of such basins has been strongly recommended, and it has been proposed to reserve certain areas on both sides of the city for this purpose; but, by the neglect of the authorities to take action, these lands have become occupied for other uses.

The system of bulkheads and piers consists of a river wall or bulkhead along the bank of the river, with piers projecting from it at regular intervals, by which the wharf line is made to greatly exceed the shore line. Vessels lying in the slips (the spaces between the piers) are protected

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from ice and the extreme action of the tides, and the ends of the piers afford suitable landing places for steamboats, lighters, etc., whose stay is but temporary, and with whom any saving in the time employed in making a landing is a desideratum. General McClellan says of this system, that "it is the simplest, the most convenient, and by far the most economical system that can be suggested."

The first dock in New York was built in 1654, near the Battery, by Daniel Litchon, a tavern keeper. The second was built in 1676. In 1728, docks extended up the East River for a mile from the Battery, and there were four wharves on the North River. The East River docks consisted of narrow slips, alternating with broad quays or moles. By 1782, these were entirely replaced by narrow piers like those of the present day, and the system had been extended for some distance up the North River.

Up to 1871, the docks, whether owned by the corporation or by private parties, were under the control of the department or bureau of the city government having charge of the streets, and all plans for their construction were subject to the approval of the Commissioners of Pilots. This latter board refused to sanction the building of sheds of any description on the piers, although they would have been of great value to the lessees, some of whom were influential enough to maintain sheds in violation of the law, while others, including many of the steamship companies, located on the New Jersey shore, from whence they have nearly all been attracted to the city by the present more liberal administration of the docks.

Under the old régime, the bulkheads were all of timber cribwork, filled with broken stone, and the piers were small, and composed of "blocks and bridges"—that is, of square blocks of cribwork connected by bridges of open pilework. The work of construction was done by contract in the most slovenly manner, and the docks were continually in such a wretched condition as to be a disgrace to the city. The

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bulkheads were constantly sinking, sliding out, and overturning; the timber of which both they and the piers were built was subject to conditions bringing about rapid decay, and the deposits of the sewers at the heads of the slips, together with the rubbish thrown overboard, made constant dredging necessary.

From time to time, many schemes for the improvement of the harbor have been brought before the people, most of them being interesting only as they show what remarkably novel plans may be proposed for application in cases where methods of known value would be the most feasible. One of these, which was made the subject of investigation by a committee of the Legislature in 1836, proposed the construction, in the Hudson River, parallel to the shore and at a distance of one thousand feet from it, a stone quay, to be surmounted by storehouses and an avenue, and to be connected with the city by occasional causeways of open piling provided with drawbridges. The construction was to be begun at a point off the Battery, and was to be extended northward as trade might demand.

This proposal shows in a marked manner how little consideration was given to the subject of limiting the encroachment upon the river channels, upon the preserval of which the whole value of the harbor is dependent, the depths at the entrances of the harbor being governed by the volume and rapidity of the tidal currents.

The encroachments by filling along the shores had become so extensive that a Commission was appointed in 1855 to make a thorough investigation of the subject and to fix a system of exterior lines beyond which no structures should be built. The commissioners had extensive surveys made by members of the Coast Survey, and their reports, made in 1856 and 1857, contain the most valuable information about the harbor that has ever been published. Acting on the advice of a committee, consisting of Superintendent Bache of the Coast Survey, General Totten, and

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Commander Davis, U. S. N., the commissioners adopted a system of lines for the whole water-front of the harbor under the jurisdiction of the State of New York; one, the Bulkhead line, being the exterior limit of solid filling, and the other, the Pier-head line, the exterior limit of piers. These have been superseded in the case of New York City by a system of lines laid down by the Department of Docks.

April 9th, 1870, was the beginning of a new era in the history of the New York docks, that being the date of the appointment of "The Board of Commissioners governing the Department of Docks." This Board was intrusted with the selection of a system of docks and their construction, besides which it was given supreme authority over all dock structures and lands under water belonging to the city, and power to order the repair and rebuilding of docks belonging to others than the corporation, according to the plans and under the supervision of the engineers of the department.

General George B. McClellan, the first engineer-in-chief, reported in favor of a system of piers and bulkheads, recommending the construction of a permanent bulkhead wall of concrete and granite masonry, from which timber piers of the best construction should be projected. This system was adopted by the Dock Commissioners and confirmed by the Commissioners of the Sinking Fund, and all the constructions on the water-front of the city since that time have been governed by its principles.

A number of short sections of the bulkhead wall have been completed at points on the North River, amounting altogether to about 4,100 feet. In the construction, three distinct plans have been followed, consisting essentially of a foundation of piling, ballasted with broken stone, from which the concrete structure is carried up nearly to mean low water, the wall above consisting of a granite facing with a concrete backing.

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According to the design of Mr. Newton (the first plan followed), the concrete structure was composed of two courses of concrete blocks, each six feet high, twenty-five to forty-five tons in weight, and moulded and dried in the air. General Grahame, the second engineer-in-chief, attempted to substitute for these a huge monolith of concrete, manufactured on the spot, and deposited *in situ*, from buckets, within a false work of planking; but the work was a failure, and a new plan was devised by Mr. Greene, the present engineer-in-chief, which may be described as consisting of a foundation and relieving platform of piling, filled with cobble and flanked with rip-rap, the structure being carried up to within about two feet of mean low water by single concrete blocks, twelve feet long and weighing seventy tons, the facing of granite and the concrete backing being about the same as in the other cases.

In 1871, the construction of a pier, consisting of a number of granite arches filled with concrete, on concrete subpiers, was begun at Pier 1, North River, which was completed in 1875.

The present policy of the Dock Department is to continue the construction of the bulkhead wall; to construct new timber piers as fast as the old ones wear out and can be replaced to advantage; and to do all repairing that may be necessary. The receipts of the department from dock rents and wharfages greatly exceed the expenditures, so that the most valuable property of the city is being permanently improved without expense to the taxpayers, while the fees exacted from those using the docks are extremely moderate.

References.—Report relative to a great pier in the North River, 1836; Reports of Harbor Commissioners, 1856 and 1857; New York Legislative Documents, 1867, S. 46; Annual Reports of the Dock Department; London *Engineering*, 1875, Feb. 5, July 2 and 9; *Scientific American*, May 15, 1875; *Engineering News*, 1880.

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CASTING AND FOUNDING.

BY W. H. COOPER.

We are indebted to the fusibility of the metals for the power of giving to them, with great facility and perfection, any required form, by pouring them, whilst in a fluid state, into moulds of various kinds, of which, in general, the castings become exact counterparts.

Some few objects are cast in open moulds, the upper surface of the metal becoming flat under the influence of gravity, as in the casting of ingots, flat plates and other similar objects; but in general the metals are cast in close moulds, so that it becomes necessary to provide one or more apertures or ingates for pouring in the metal, and for allowing the escape of air. Moulds made of metal must be sufficiently hot to avoid chilling or solidifying the fluid metal before it has time to adapt itself throughout to every part of the mould. And when made of earthy materials, although moisture is essential to their construction, little or none should remain at the time they are filled.

The earthen moulds must also be sufficiently pervious to air that any vapor or gases formed either at the moment of casting or during the solidification of the metal may easily escape. Otherwise, if the gases are rapidly formed, there is danger that the metal will be blown from the mould with a violent explosion, or, when more slowly formed and unable to escape, the bubbles of gas will displace the fluid metal and render it spongy or porous. The casting is then said to be *blown.* It not infrequently occurs that castings which appear good and sound externally are filled with hidden defects, because the surface being first cooled the bubbles of air will attempt to break their way through the central and still soft parts of the metal.

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The perfection of castings depends much on the skill of the pattern-maker, who should thoroughly understand the practice of the moulder, or he is liable to make the patterns in such a manner as to render them useless.

Straight-grained deal, pine and mahogany are the best woods for making patterns, as they remain serviceable longest. Screws should be used in preference to nails, as alterations may be more easily made, and for the same reason dove-tails, tenons, and dowels are also good.

Foundry patterns should always be made a little tapering in the parts which enter most deeply into the sand whenever it will not materially injure the castings, in order that they may be more easily removed after moulding. This taper amounts to from one-sixteenth to one-eighth of an inch in a foot and sometimes to much more.

When foundry patterns are exactly parallel, the friction of the sand against their sides is so great that considerable force is required to remove them, and the sand is torn down unless the patterns are knocked about a good deal in the mould to enlarge the space around them. This rough usage frequently injures the patterns and causes the castings to become irregularly larger than intended, and defective in shape, from the mischief sustained by the moulds and patterns.

Sharp internal angles should also be avoided as much as possible, as they leave sharp edges or arrises in the sand, which are liable to be broken down on the removal of the pattern, or washed down by the entry of the metal into the mould. Either the angle of the mould should be filled with wood, wax, or putty, or the sharp edges of the sand should be chamfered off with a knife or trowel. Sharp internal angles are also very injudicious in respect to the strength of castings, as they seem to denote where they will be likely to break.

Before the patterns reach the founder's hands all the glue remaining on their surfaces should be carefully scraped off,

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or it will adhere to and break down the sand. The best way is to paint or varnish wooden patterns, to prevent their absorbing moisture and the warping of the surface and sticking of the sand. Whether painted or not, they deliver better from the mould when they are well brushed with black-lead.

Foundry patterns are also made in metal. These are excellent, as they are permanent, and when very small are less liable to be blown away by the bellows used for removing the loose sand and dust from the moulds. To prevent iron patterns from rusting and to make them deliver more easily, they should be allowed to become slightly rusty, and then warmed and beeswax rubbed over them, the excess removed, and the remainder polished after cooling, with a hard brush. Wax is also used by the founder for stopping up any little holes in the wooden patterns. Whitening is also used for this purpose, but is not as good. Very rough patterns are seared with a hot iron. The good workman, however, leaves no necessity for these corrections, and the perfection of the pattern is well repaid by the superior character of the castings.

Metallic patterns frequently have holes tapped in them for receiving handles, which screw in, to facilitate their removal from the sand. Large wooden patterns should also have iron plates let into them, into which handles can be screwed. Otherwise, the founder is obliged to drive pointed wires into them, and thereby injure the patterns.

The tools used in making the moulds are few and simple —a sieve, shovel, rammer, strike, mallet, a knife, and two or three loosening wires and little trowels, which it is unnecessary to describe.

The principal materials for making foundry moulds are very fine sand and loam. They are found mixed in various proportions, so that the proportion proper for different uses cannot be well defined; but it is always best to employ the

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least quantity of loam that will suffice. These materials are seldom used in the raw state for brass casting, although more so for iron, and the moulds made from fresh sand are always dried. The ordinary moulds are made of the old damp sand, and they are generally poured immediately or while they are green. Sometimes they are more or less dried upon the face. The old working sand is considerably less adhesive than the new, and of a dark-brown color. This arises from the brick-dust, flour, and charcoal-dust used in the moulding becoming mixed with the general stock. Additions of fresh sand must therefore be occasionally made, so that when slightly moist and pressed firmly in the hand it may form a moderately hard, compact lump.

Red brick-dust is generally used to make the parting of the mould or to prevent the damp sand in the separate parts of the flask from adhering together.

The face of the mould which receives the metal is generally dusted with meal, or waste flour. But in large works powdered chalk or wood or tan ashes are used, because cheaper. The moulds for the finest brass castings are faced either with charcoal, loamstone, rottenstone or mixtures of them. The moulds are frequently inverted and dried over a dull fire of cork shavings, or when dried are smoked over pitch or black resin in an iron ladle.

The cores or loose internal parts of the moulds, for forming holes and recesses, are made of various proportions of new sand, loam and horse-dung. They all require to be thoroughly dried, and those containing horse-dung must be well burned at a red heat. This consumes the straw, and makes them porous and of a brick-red color.

In making the various moulds, it becomes necessary to pursue a medium course between the conditions best suited to the formation of the moulds and those most suitable for the filling of them with the molten metal without danger of accident. Thus, within certain limits, the more loam and

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moisture the sand contains and the more closely it is rammed, the better will be the impression of the model; but the moist and impervious condition of the mould incur greater risk of accident both from the moisture present and the non-escape of the air. The mould should, therefore, be made of sand which is as dry as practicable, to render the mould as porous as possible. Where much loam is used, the moulds must be thoroughly dried by heat before casting the metal.

As castings contract considerably in cooling, the moulds for large and slight castings must not be too strongly rammed or too thoroughly dried, or their strength may exceed that of the red-hot metal whilst in the act of shrinking, and the casting be broken in consequence. If the mould is the weaker of the two, its sides will simply be broken down without injury to the casting.

The method of preparing a mould is as follows: The sand having been prepared, the moulder frees the patterns from all glue and adhering foreign particles. He then selects the most appropriate *flasks*, which are frames, or boxes without top or bottom, made of wood, for containing and holding the sand. The models are then examined to ascertain the most appropriate way of inserting them into the sand. The bottom flask is then placed upon a board, face downwards. A small portion of strong facing-sand is rubbed through a sieve, the remainder shovelled in and driven moderately hard into the flask. The surface is then struck off level with a straight metal bar or scraper, a little loose sand sprinkled on the surface, upon which another board is placed and rubbed down close.

The two boards and the flask between them are then turned over together; the top board is removed, and fine brick-dust is dusted over the clean surface of moist sand from a linen bag. The excess of brick-dust is removed with a pair of hand-bellows, and the bottom half of the

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mould is then ready for receiving the patterns. The models are next arranged upon the face of the sand, so as to leave space enough between them to prevent the parts breaking into each other, and for the passages by which the metal is to be introduced and the air allowed to escape. Those patterns which are cylindrical, or thick, are partly sunk into the sand by scraping out hollow recesses, and driving the models in with a mallet, and the general surface of the sand repaired with a knife, trowel, or piece of sheet-steel. The level of the sand should coincide with that of the greatest diameter or section of the model.

After the sand is made good to the edges of the patterns, brick-dust is again shaken over it, the patterns also receiving a portion. The upper part of the flask is then fitted to the lower by pins of iron fitting in metal eyes; and a little strong sand is sifted in. It is then filled up with the ordinary sand, which is rammed down and struck off flush with the edge of the flask. The dry powder serves to keep the two halves from sticking together.

In order to open the mould for the extraction of the patterns, a board is placed on the top of the flask and struck smartly at different places with a mallet. The upper part of the flask is then gently lifted perpendicularly and inverted on its board. Should it happen that any considerable portion of the mould, say a part as large as a cent, is broken down in one piece, the cavity is moistened and the mould again carefully closed and lightly struck. On the second lifting the defect will usually be remedied. All breaks in the sand are carefully repaired before the extraction of the patterns.

To remove the models, they are driven slightly sidewise with taps of a mallet, so as to loosen them by enlarging the space around them. The patterns are then lifted out, and any sand which may have been torn down must be carefully replaced, or fresh sand is used for the repairing.

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Should the flask only contain one or two objects, the ingate or runner is now scooped out of the sand, so as to lead from the pouring-hole to the object. Where several objects are in the same flask, a large central channel, with branches, is made. The entrance of the pouring-hole is smoothed and compressed, and all the loose sand blown out of the mould with hand-bellows.

The faces of both halves of the mould are next dusted with meal-dust or waste flour, put together, and the boards replaced—one just flush with the side of the flask in which the pouring-hole is situated, and the other (on the side from which the metal is to be poured) is put about two inches below, and secured by hand-screws. The mould is then held mouth downwards, that any sand loosened in the screwing down may fall out. It is now ready to be filled.

Where the bottom half of the flask requires to be much cut away for imbedding the patterns, it is usual, when the second half is completed, to destroy the first or *false* side, which has been hastily made, and to repeat it by inverting the upper flask and proceeding as before.

When many copies of the same patterns are required, an *odd side* is prepared—that is, a flask is chosen which has one upper and two lower portions. One of the latter is carefully arranged, with all the patterns barely half-way imbedded in the sand, so that when the top is filled, and both are turned over, all of the patterns are left in the new side. A second lower portion is then made for receiving the metal while the first one is kept for rearranging the patterns. By this plan, the trouble of arranging the patterns for every separate mould is avoided, as the patterns are simply replaced in the odd side, and the routine of forming the two working sides is repeated.

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NOTES

A crystal of pyrite, from Traversella, Piedmont, consisting of the diploid and hemi-tetrahexahedron, has been presented to the Mineralogical Collection by Prof. J. P. Cooke, of Harvard.

The collection belonging to the late Prof. Henry How, Vice-President and Professor of Chemistry of Kings College, Windsor, Nova Scotia, has recently been purchased by Messrs. A. H. & C. T. Barney, and presented to the School. This collection contains some three thousand specimens, largely composed of zoolites, for which the locality is famous, and possesses additional interest and value from the fact that Prof. How, although a naturalist, was as a specialist, a mineralogist, and most of the labor which caused the publication of his twenty papers on mineralogy was the result of investigations on specimens in his own collection.

Frequent inquiry is made about the comparative rank of the School of Mines' collection. In reply, I would say that, as a *working* collection, it is probably second to none in the country. There are other collections, many of them the property of individuals, which have finer specimens, some of them being unique. In such collections, no attempt is made to have localities, which afford specimens differing slightly from the types, represented.

It is greatly to be regretted that much scientific work which might accrue to the credit of the Department of Mineralogy is lost, for the reason that there is no one to make analyses of minerals. The labor of the assistant in the department is so largely mechanical and routine, and his time is so fully taxed with it, that specimens brought to him for examination, and frequently proving to be new species or interesting varieties of old ones, are obliged to be taken elsewhere for further investigation.

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If a Scholarship were created for research in mineralogy exclusively, the work being directed by the Professor of Mineralogy, such work would not go to other institutions, and the School would be greatly benefitted thereby. C. A. C.

Alcohol and acetic acid, according to J. Béchamp, are constant and necessary products of putrefaction. He has discovered alcohol also in small quantities in normal and sound animal tissues—a fact of importance in chemico-judicial inquiries.

In a memoir recently published at Christiania, Herr Sophus Tromboldt considers that it may be accepted as certain that the aurora borealis is a local phenomenon, circumscribed by very narrow limits, and occurring not far from the surface of the earth. The light, he finds from a careful comparison of a large number of observations, is generally white, though sometimes red or green; but further north than Bergen the aurora often presents spectral colors. He believes, also, that there is now evidence enough to accept the statement that auroral displays are sometimes attended with sound.

Some of the luminous protuberances on the surface of the sun, since the late period of activity began, have been estimated by M. T. Thollon to have attained a height of 100,000 kilometres.

Dr. James D. Dana, in recently published papers, has advanced sufficient facts to enable him to deduce scientifically that the limestone of Westchester County and New York island, and the conformably associated metamorphic rocks, are of lower silurian age; and, further, that the limestone and conformably associated rocks of the Green Mountain region, from Vermont to New York island, are also of lower silurian age.

It is said that the light from the electric arc, and from electric lamps, is capable of producing all the symptoms of sunburn on a person of light complexion, on exposure to it for some time, and that freckles are developed as rapidly as in sunlight at midsummer.

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A remarkable result has recently been achieved by Sir W. Armstrong, in the production of a gun weighing ninety-five hundred-weight, discharging a projectile weighing 120 pounds with a velocity of 2,064 feet per second—that is to say, having 3,545 foot tons of stored-up energy, or 746.3 foot tons per ton weight of gun. The gun is an experimental one, and, the result being so extraordinary, is supposed to be exceptional.

Nature says that an electric cable manufacturing firm in Neuchâtel have succeeded in devising a method of laying cables whereby the induction of the electric current from one wire to another, although the wires are in juxtaposition, is prevented. This discovery, of which no details are yet given, removes, it is asserted, the last obstacle in the way of the widest possible extension of facilities for telephonic communication.

Herr V. Lippman finds that when cane sugar, in solution and pure, is charged with carbon dioxide, it is slowly converted into inverted sugar, and that this change is hastened when the carbon dioxide is pumped into the sugar solution under pressure.

Professor Graham Bell has been endeavoring to apply the photophone to the study of such sounds as may occur at the surface of the sun. He has not, as yet, secured very striking results, but has obtained enough to warrant further research.

Tests of the durability of steel rails show that the hardest rails do not wear the best. In one instance, a hard rail was worn away one-sixteenth of an inch by a traffic amounting to 5,251,000 tons, while a softer one required 8,402,000 tons to wear it away the same amount. In another case, a soft rail withstood exactly twice as much wear as a hard one. On analysis, the softer rail was found to contain 99,475 per cent. of iron, and traces of carbon, phosphorus, silicon, manganese, sulphur, and copper.

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THE SCHOOL OF MINES QUARTERLY.

MARCH, 1881.

EDITORIAL.

In the fall of 1879, the SCHOOL OF MINES QUARTERLY was started as a medium for the publication of the results of the observations and study of the students of this institution. Its success in that respect has been most gratifying, and it has given to all who have contributed or subscribed to it a feeling of union in the pursuit of the subjects dealt with in the school.

A feeling has long existed that not only the students, but the graduates of the school, had a lively interest in these pursuits, and moreover that the graduates had opportunities for observation and experience, the results of which, if made known to their fellow graduates or to those as yet students, might be of the highest practical value.

In reponse to this idea, the Alumni Association of the School of Mines considered the question of uniting the efforts of the graduates with those of the students in presenting a publication which should represent the experience of all, in subjects in which all are presumably interested, and soliciting notes of observations, as well as papers on pro-

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fessional subjects from both graduates and students. The result has been an increase in the number of editors, some of whom are taken from the members of the Alumni Association, with the intention of extending the scope of the publication by printing notes and papers which may promise to be of interest to those engaged, or about to be engaged, in the pursuit of engineering, chemistry, etc.

We most earnestly solicit the coöperation of all who may have an interest in promoting such a cause. Contributions of notes of observations in the field or the laboratory and information regarding the location or business of graduates will be thankfully received from all who feel the benefit of union with their fellow workers in the same or kindred fields. Let each one feel that he has a personal interest in the success of the QUARTERLY, and that every item of professional interest that can be contributed to its pages helps to strengthen the bond of union among those engaged in these pursuits.

The QUARTERLY is not intended to be a source of financial profit to any one, but simply as an aid in the study of subjects of professional interest, and a source of information regarding the movements of School of Mines graduates. The distinction between graduates and students has here been made because the publication was originally started as an undergraduate periodical, but the distinction is one more of name than of fact, for should the graduate cease to be a student, he would then resign all expectation of professional advancement.

As intimated, in addition to technical papers and notes, there will be a department devoted to giving information regarding the addresses and work of the graduates, which, it is expected, will be of interest to all, and information of that kind is requested from those who may be able to impart it.

The present number is issued under the new auspices, and though possibly open to unfavorable criticism in some respects, on account of the limited time in which it had to

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be prepared, and the inevitable stiffness of joints incident to the starting of a new piece of machinery, it must be remembered by all who are or have been connected with the School of Mines, or have an interest, professional or otherwise, in the subjects there dealt with, that it is only by their support in the way of subscriptions and contributions that the QUARTERLY can be improved or kept to the high standard at which it aims.

ON THE ACTION OF COLD, CONCENTRATED SULPHURIC ACID—ON LEAD AND ITS ALLOYS.

BY LUCIUS PITKIN.

UNTIL quite recently it has been regarded as almost indisputable that the purer the lead, the less action would sulphuric acid have upon it. In opposition to this idea, a very interesting paper was presented by Mr. James Napier, before the Glasgow Philosophical Society, a full report of which can be found in the *Chemical News* for December, 1880.

Briefly abstracted it is as follows: Sulphuric acid was shipped in cases of sheet lead, all of which either bulged badly or burst. To ascertain the cause of this action, the acid, the lead, and the gas causing the pressure were analyzed.

The acid was of Sp. Gr. 1.842 and of the following composition, H_2SO_4 99.78—SO_2 0.02—Pb SO_4 0.13—Ca SO_4 0.07.

The lead was of extraordinary purity, containing according to the analysis Pb 99.96—Cu. 0.04. The gas evolved was pure hydrogen.

Exposing a known surface of the lead to the action of

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cold concentrated sulphuric acid, gas was given off equivalent to 41 cubic inches per square foot lead exposed.

Another sample from a concentrating pan, (No. 1) of the same composition gave under similar circumstances, 16 cubic inches per square foot. A second sample of lead (No. 2) having a composition of Pb. 99.50 Cu. 0.08. Sb. 0.42 yielded only ⅓ cubic inches per square foot.

As a basis for further experiments, Mr. Napier took a soft lead not analyzed, similar to No. 1, which averaging several determinations yielded 9.4 cubic inches per square foot. Calling this lead No. 3, the following alloys were made and yielded the following amounts of gas by the action of sulphuric acid.

I.	Lead No. 3, 99.25 Sb. 0.75	0.25 cu.. inch.
II.	Lead No. 3, 98.88 Cu. 0.39 Sb. 0.75	0.10 cu. inch.
III.	Lead No. 3, 99.63 Cu. 0 37	1.42 cu. inch.
IV.	Lead No. 3, 99.64 Zn. .37	2 cu. inch.

The paper was discussed by the society, and the President in summing up, said the following points appeared proven :

1. Chemically pure lead was unsuitable for sulphuric acid evaporating pans.

2. Lead containing certain impurities, and especially zinc, were unsuitable.

3. Antimony seemed to render the lead more durable.

4. The subject required further investigation.

It is to this investigation that the remainder of this paper will be devoted.

The lead taken as a basis for the alloys which I have

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experimented upon, was a chemically pure lead made by Merck, of Darmstadt, and guaranteed by him. The method employed differed from that made use of by Napier, who measured the gas evolved from a known surface of lead.

In the following experiments, the action of the sulphuric acid was measured by the amount of lead or alloy converted into sulphate, which was ascertained by weighing the alloy before immersing in sulphuric acid, and after the action, cleansing from any adhearing sulphate and reweighing.

In all forty (40) samples of lead and alloys of known composition were acted upon by the acid and the action measured. In some cases the results may appear anomalous, but not more so than the case reported by Napier, in which lead of the same composition gave off under similiar circumstances, in one case 41 cubic inches per square foot, in the other only 16 cubic inches. In the making of the alloys, great care was taken to obtain as homogeneous a mixture as possible, and in order to avoid oxidation, the fusion was performed under a layer of powdered charcoal. The making of 40 alloys was thus by far the most tedious part of the investigation.

The alloys experimented upon were those of lead with antimony, tin, bismuth, cadmium, silver and zinc. After the preparation of the alloys, they were carefully rolled to about the same thickness, and the same surface exposed in each case to the action of the same amount of acid for a like time.

The surface exposed was 2 sq. in., and the amount of acid used 10 c.c. The action was allowed to proceed 24 hours at a temperature of 20° C.

The acid employed was C. P. sulphuric acid of Sp. Gr. 1825. In the tables the first column gives composition of alloys; the second, the loss of lead per sq. foot of surface exposed, the weight being in grammes; the third, the amount of gas evolved calculated from the quantity of lead converted into the sulphate.

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1.	C. P. Lead.	1.296 grms.	9 cu. in.
2.	"	2.088 "	14.5 "
3.	"	2.952 "	20.5 "
4.	"	2.232 "	15.5 "

Average loss for pure lead, 2.160 grms. per sq. foot.

Average gas evolved from sq. ft., 15 cu. in.

In all cases quite a vigorous evolution of hydrogen took place at the instant of immersion, while in an hour scarcely any action was perceptible. It will be noticed that the quantity of hydrogen evolved agrees quite closely with the amount given off by lead not in Mr. Napier's experiments.

In the case of the alloys, however, I did not find that the addition of foreign metals produced such a change in the amount of lead converted into sulphate, as the following figures will show.

In computing the amount of gas, the loss is calculated for convenience as entirely lead..

ANTIMONY ALLOYS.

5	Pb 100 Sb	0.5 parts	1.872 gms	13 cu. in	
6	Pb 100 Sb	1 "	2.016 "	14 "	
7	Pb 100 Sb	2 "	2.016 "	14 "	
8	Pb 100 Sb	3 "	1.512 "	10 "	
9	Pb 100 Sb	5 "	1.584 "	11 "	
10	Pb 100 Sb	10 "	1.584 "	11 "	

It will be seen from this that under the conditions of the experiment, the antimony did not seem to affect the lead to such a degree as in Mr. Napier's researches, although retarding the action of the acid.

It shows, however, what a large amount of antimony may be present without affecting the solubility of the lead.

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TIN ALLOYS.

11	Pb 100 Sn	0.5	parts	2.802	gms.	19	cu. in.
12	Pb 100 Sn	1	"	3.744	"	26	"
13	Pb 100 Sn	2	"	3.080	"	22	"
14	Pb 100 Sn	3	"	2.952	"	21	"
15	Pb 100 Sn	5	"	3.232	"	23	"
16	Pb 100 Sn	10	"	2.380	"	17	"

In the case of the alloys with tin, the action is in all cases augmented, but does not seem to increase in proportion to the amount of tin present.

BISMUTH ALLOYS.

17	Pb 100 Bi	0.5	parts,	1.800	gms.	12	cu. in.
18	Pb 100 Bi	1	"	4.032	"	28	"
19	Pb 100 Bi	2	"	1.656	"	11	"
20	Pb 100 Bi	3	"	1.728	"	12	"
21	Pb 100 Bi	5	"	2.232	"	16	"
22	Pb 100 Bi	10	"	3.600	"	25	"

The figures in number 18 are evidently anomalous, and probably were the result of an imperfect admixture or separation of the Bi and Pb. If they are disregarded we would have the general action of bismuth in the alloys with lead as retarding in quantities less than 5 per cent., and above that figure hastening the formation of lead sulphate.

CADMIUM ALLOYS.

23	Pb 100 Cd	0.5	parts	1.728	gms.	12	cu. in.
24	Pb 100 Cd	1	"	1.656	"	11	"
25	Pb 100 Cd	2	"	1.296	"	9	"
26	Pb 100 Cd	3	"	1.728	"	12	"
27	Pb 100 Cd	5	"	1.296	"	9	"
28	Pb 100 Cd	10	"	3.528	"	24	"

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In regard to cadmium we have it decreasing the solubility of lead to a greater extent even than antimony, while above 5 per cent. it raises its solubility.

SILVER ALLOYS.

29	Pb	100	Ag	0.5	parts	1.584	gms.	11 cu. in.
30	Pb	100	Ag	1	"	1.728	"	12 "
31	Pb	100	Ag	2	"	1.944	"	13 "
32	Pb	100	Ag	3	"	1.584	"	11 "
33	Pb	100	Ag	5	"	2.016	"	14 "
34	Pb	100	Ag	10	"	2.448	"	17 "

Silver seems to exert very little influence, in small proportion, slightly decreasing the action, in large proportion slightly increasing the solubility.

ZINC ALLOYS.

35	Pb	100	Zn	0.5	parts	2.664	gms	18 cu in
36	Pb	100	"	1	"	2.304	"	16 "
37	Pb	100	"	2	"	3.816	"	26 "
38	Pb	100	"	3	"	2.664	"	18 "
39	Pb	100	"	5	"	4.032	"	28 "
40	Pb	100	"	10	"	4.392	"	30 "

The solubilities of the alloys of lead and zinc are thus greater than those of lead with any other metal experimented upon. To sum up the results of the work, it appears:

1. The metals, Antimony, Bismuth, Cadmium, and Silver in small quantities, protect lead from the action of the cold sulphuric acid; while in proportions above 5 per cent., they all, with the exception of antimony, increase the solubility.

2. Antimony when present even to the amount of 10 per cent. decreases the solubility of the lead.

3. Tin and zinc alloys are more affected than pure lead.

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THE WESTMORELAND SHAFT.*

BY W. P. LITTLE AND T. B. STEARNS. ('81)

A NEW shaft has recently been sunk by the Westmoreland Coal Company, on the line of the Pennsylvania Railroad, near Manor Station, Westmoreland Co., Pa., in order to develop a large basin in the Pittsburg Seam.

The Pittsburg Seam lies in the upper production coal measures, and extends with wonderful uniformity from the city of Pittsburgh (whence the name) far into Eastern Pennsylvania, and westward and southward into West Virginia and Ohio, covering an area of 14,000 square miles.

The coal varies in character from a highly bituminous coal in the West to a semi-bituminous coal in the East. In Westmoreland County the coal is an excellent gas coal, as is shown by the following analyses:

	BY C. W. CORSSON, M. D.		BY C. F. CHANDLER PH. D.
	1	2	
Coke,	62 80	62.80	58.00
Vol. Matter,	37.20	35.00	36.00
Ash,	6.27	3.20	6.00
Sulphur,	0.30	——	——
Sulph. in Coke	0.14	0.203	——

The strata comprising the coal basin are everywhere nearly horizontal, but at the same time roll gently in broad basins, several miles in width, divided by lines of gentle upheaval. These basins are subdivided by minor axes of upheaval, and contain still smaller areas of subsidence,

* Abstract of a memoir, handed in October 4th, 1880, as a part of the work of the Summer School of Practical Mining. The original memoir is exceedingly valuable, and is profusely illustrated with sketches in the text and large scale working-drawings, and tracings.—ED.

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locally known as "swamps," from the difficulty of draining them in mining. The basin to be mined from the new shaft is known as the third subdivision of the third basin, or the Lisbon synclinal, and from east to west is about ten miles in width. The "cleat," a natural cleavage or jointing of the coal, has a direction nearly at right angles to the synclinal. The workings are so laid out as to take full advantage of this "cleat" in mining the coal.

SINKING THE SHAFT.

The contract to sink the shaft was given to the Pennsylvania Diamond Drill Company, and was accomplished by their Long Hole Process, * using the solid bit in boring. The shaft was sunk 18 ft. by 9 ft., the holes being bored the entire depth, one hundred and seventy-one feet. Near the bottom a water-bearing stratum was struck, and the water rose through the holes in such quantities as to necessitate constant pumping during the operation of sinking. The explosive used was dynamite, the holes all being charged to a certain depth, and the charges fired simultaneously by battery. The depth removed at each blast was regulated by the nature of the rock, being two feet for hard sandstone and six feet for shale. Water was the only tamping used. The difficulty in placing the cartridges, due to the upper pressure of the water, was overcome by the use of pine plugs driven ahead of the cartridges. The material excavated was removed in a bucket, hoisted by a pair of temporary engines. Ventilation was effected by a brattice; the upcast was given by the exhaust steam from the pumps.. The permanent timbering was put in as the sinking progressed, and consists of the ordinary square sets separated by struts. This method of sinking, in consequence of the water, and on account of extra work required in dressing two of the

* See Trans. Am. Inst. M. E., Vol. 1 p. 261, for a description of this method of shaft sinking.

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sides of the shaft through the holes not having been bored straight, proved very unsatisfactory and expensive.

GENERAL DESCRIPTION OF MINE.

The mine has just been opened. The coal to be removed by this shaft covers an area of about three square miles; the dip of the basin is very slight, and is upwards in all directions from the bottom of the shaft. Owing to the nature of the deposit, the system of exploration to be adopted is on a grand scale. The intention is to run a straight entry the entire length of the coal field, in which a tail rope or endless chain system will be operated.

Since the shaft is situated in the synclinal axis, the water flows toward it from all sides, making the system of drainage very simple.

The pure air enters the mine through the slope and cage shaft, and after being guided through the workings by the usual doors and stoppings, is drawn out by means of a fan, through an air shaft contiguous to the cage shaft. The fan is of the Guibal type, 12 feet in diameter and worked by a 10x12 inch vertical Snyder engine. The fan for safety in case of an explosion is over 40 feet from the mouth of the shaft, with which it is connected by a brick tube 9 feet in diameter.

The surface buildings consist of a boiler and engine house facing the shaft, and distant from it about thirty feet. The tipple and weighing room is on the opposit side of the shaft from the engine house, and is in part built on a trestle out over the sidings of the Pennsylvania Railroad. This extension is to support the hopper under which the coal-cars are run. The coal from each mine car is weighed and inspected in the hopper after screening, and the miner is credited with the nut and lump coal only.

A fan house situated one side of the shaft, contains the fan and driving engine already mentioned.

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A small blacksmith shop and storehouse complete the list of surface buildings. The water supply is obtained by damming several small streams on a hill near the mine.

Underground Haulage is at present effected by mules, though the endless chain or tail rope system will eventually be employed. Separate parallel entries are used for full and empty cars. The mules bring the loaded cars to within a short distance of the foot of the shaft. The remainder of the trip the cars are run by gravity, the track having a down grade of 1 foot to 100. A similar arrangement is adopted for the empty cars, so that the mules do not have to come to the foot of the shaft; thus avoiding accidents, and facilitating the rapid handling of the cars.

Hoisting.—The cars are hoisted in cages made of wood, and braced with sheet-iron. They are provided with safety catches, hood, and blocking arrangement to prevent the cars from slipping off. The cages are actuated by a pair of direct acting, non-condensing Snyder engines, each 18x36. The drum is grooved spirally, and the ropes are so attached that the cages act reciprocally. The mouth of the shaft is supplied with keeps to support the cage, and with gates to guard the entrance when the cage is not at the surface.

The derrick is a wooden frame on a stone foundation, and is braced and tied securely by iron.

The sheaves are supported by the derrick, and are shaped like bicycle wheels.

The engineer guides the engine by a long lever acting on the throttle valve. He faces the shaft-mouth during the hoisting, and a tell-tale and signals show him, at any moment, the position of the cage.

Handling of Coal on the Surface.—For this purpose several novel appliances are employed. The cars run on the surface almost automatically, but four hands being required.

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The chief novelty is the inclined plane, up which the empty cars from the tipple, and the full cars of slate from the shaft, are hoisted. Thence the empty cars run by a down grade to the mouth of the shaft, and the slate cars to the slate dump, respectively. This sorting of the cars is accomplished by an ingenious switch, so arranged as to be moved automatically by the heavy loaded slate cars only, switching them off on the slate track, while the light empty cars pass on without affecting the position of the switch.

The hoisting appliances of the plane consist of an endless chain, from which project vertical arms. These arms come in contact with the axles of the cars, raising them up the plane. The chain is moved from the hoisting sheave axle by a system of shafts and pulleys.

[The memoir concludes with many interesting and valuable tables concerning the cost of plant, wages of men, value of tools and supplies, etc. Also a brief summary of the present state of the law on the subject of coal leases in Pennsylvania, giving the necessary precautions to be taken in leasing or buying lands, to protect the lessees from prosecution for damages.]—ED.

THE PASTRANA MINE. *

BY J. C. F. RANDOLPH, E. M. ('69)

HAD the Pastrana vein never been discovered, it is probable that the great wealth enclosed in the silver veins in the valley of Batopilas would be still unsuspected. Like all the subsequent discoveries of silver veins in this locality, its discovery was due to mere chance. Its early history is somewhat doubtful, as no records exist. It is believed, however, to have first been worked by the Spaniards, at the beginning of the last century.

* * * * * * *

The two principal epochs of its production were between

* Extracts by permission, from a professional report on the Pastrana Mine, near Batopilas, Chihuahua, Mexico.

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the years 1730 to 1740, and from 1779 to 1792. Escudero, in his statistics of Chihuahua, states that in 1730 the mine went into extraordinary bonanza for ten years, producing many millions of dollars. During the years that preceded this period, it had been continuously in good product. From 1740 to 1779 it continued productive, though not a bonanza. In 1779, however, it again went into great bonanza. In these two periods of great bonanza, the Pastrana mine is believed to have produced from twenty to twenty-five millions of dollars.

* * * * * * *

In 1792, while still in bonanza, an accident occurred which caused mining work on the Pastrana to cease. Local legend states that the workings were inundated by the breaking of a water-spout, and that many men, being caught unawares, lost their lives. This may have been actually the case, but evidence of a far more serious accidence is shown on the surface. Perhaps as the results of a great influx of water from a water-spout, acting in unsupported, irregular workings, or possibly from bad mining alone, very certain it is that large bodies of ground about the Mesquite shaft caved at that time. This caving blotted out the Mesquite shaft on the surface, and has caused a depression more than 50 feet deep and 200 feet long.

The Spaniards were careless miners, as all their old workings about Batopilas show, and it is probable that this accident caused a wholesome terror of continuing mining work in still accessible workings (since they were undoubtedly just as badly driven and as insecure as those which fell in), and caused complete abandonment of mining at that time. It is probable, too, that if this accident occurred through a sudden influx of water, this, in itself, was too great an obstacle to be overcome by the limited means at hand. At that time the Spaniards were not familiar with the utility of drainage levels, and knew nothing about pumps and

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steam. This accident occurring at a time of remarkable bonanza, it has always been believed that large pillars of rich ore were left in the mine, and are there to-day.

* * * * * * *

In 1802, while the Marquis de Bustamente was taking out his great wealth from the now famous Carmen mine, he turned his attention to the Pastrana property as well. * * * * From his workings from the shaft of Sanchez, and in extending the Cata mine, he took out a great deal of money during some eight or ten years work. * * * All of these operations on Pastrana were brought abruptly to an end by the breaking out of the Mexican revolution against Spain. Mining and all other industrial enterprise came to an end with the expulsion of the Spaniards, and for many years the country was in a disordered condition.

After the revolution, Batopilas declined to a scanty population of a dozen people; no mining work was done for years, and all the mines were abandoned. In the year 1844, a German engineer named Schleiden, wandered into the district in the interest of some English capitalists, and studied the veins carefully for a period of six months. His report was favorable to reopening a number of the old mines, and he formed plans and gave estimates especially for reopening the Pastrana, San Antonio, and Carmen veins. Owing to heavy mercantile losses by his employers, his report was not acted on by them.

During his visit an English gentleman, Mr. George Le Brun (now chief of the Mint in Alamos, State of Sonora), became interested in Schleiden's project for the Pastrana, and resolved to drive the tunnel projected by him. Mr. Le Brun was not a miner, and this tunnel cannot be regarded as a successful piece of mining, on account of lack of capital to follow it up. This tunnel is 1,172 feet in length, of large dimensions, and cost much money. In driving this tunnel, he met a number of cross veins, on some of which he drove profitable workings. At 689 feet

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from the mouth, the Pastrana vein was first encountered, and the tunnel passed beneath the workings of Serastigue and of the Mesquite, both on the old Pastrana mine. The tunnel for the remaining distance follows the vein, which is some six feet in width, full of calc spar, containing all those signs which in this district are the invariable accompaniments of native silver. In this distance some silver was taken out, but not very much.

It is a matter of common belief that if Mr. Le Brun had concentrated his whole energy and capital on the tunnel alone, instead of carrying on many other slight efforts on other parts of the property, a more brilliant success would have crowned his efforts. He, however, was forced in the year 1869 to give up the enterprise just when success seemed within his grasp. Since this time no further work has been done on the property, except by wandering gambucinos, on portions of the Cata mine. The tunnel having fallen in, in two places, since he gave up work, gangs of men were employed reopening it for several months last year, in order to permit of a complete underground examination.

* * * * * * * *

The geology of the valley is exceedingly complex, and shows the most rapid passages from syenite into diorite through a large series of rocks more or less allied to both. The diorite is the rock in which the productive silver veins are found in this locality. The most enduring and great bonanza mines, including Pastrana, and those of the Consolidated Batopilas Mining Company of New York, have been found in a variety of diorite, known locally as "white panina." Valuable mines exist also in the "black panina," another variety of diorite, but it is not looked on with equal favor. Extending from the northeast corner to the southwest corner of the belt, a distance of perhaps four-and-a-half miles, there seems to be a bonanza line of white panina, on which all the great bonanza veins of Batopilas

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lie. No great bonanza veins have as yet been found outside of this line. The celebrated mines of San Miguel, now in heavy production, are at the northernmost end of this line, and the Pastrana, Martinez, San Pedro, Valenzuela, and Roncesvalles at the middle point in it. The portion of the line represented by the Pastrana has produced more silver than all the rest of Batopilas.

The peculiarity of the district lies in its containing veins of calc spar in the diorite carrying native silver. This occurrence is only known in one other locality in the world. While near the surface chlorides of silver, black silver, and ruby silver are found, the eventual ore has always been found to be native silver, highly crystallized, and often massive. This ore is richer and more cheaply and easily treated than any other ore of silver. The classes of ore continually produced by these calc spar veins in the diorite of Batopilas are:

Bodoque.—Chloride of silver, consisting of very rich earths near the surface.

Plata Negra.—Highly crystallized and very rich black silver.

Cardenilla. — Highly crystallized and very rich ruby silver.

Plata Fuerte.—Massive native silver, in pieces of often several hundred pounds.

Brosa.—One-third calc spar, two-thirds silver; running $20,000 a ton. Large quantities of this are produced to-day by the mines of San Miguel.

Chispeado.—Two-thirds calc spar, one-third silver; running $10,000 a ton. Found accompanying Brosa silver.

Plata de Clavos.— Calc spar containing scattered nails and ferns of silver; running $500 to $5,000 a ton, and resulting from the dressing of Brosa and Chispeado.

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Azogues.—Amalgamating ores, containing finely disseminated silver, and running from $50 to $500 a ton, in large quantities, and containing strings and bonanzitas of Brosa and Chispeado of great value enclosed in them.

* * * * * * *

On Leading Minerals or "Pintas."—The vein in the tunnel is large and promising, full of the white calc spar, which in this belt is the mother of silver. At points it carries "pintas," or leading minerals of great significance. As is well known, a bonanza is a concentration, about a line or nucleus, of mineral attracted and segregated from the surrounding vein rock. The cause of this action is not known, and while it is exceedingly common in veins of iron, lead, copper, silver, and veins containing both gold and silver, there are no facts to show the exciting cause. A bonanza is, therefore, always surrounded by a stretch of barren ground, since it represents the aggregation of all the mineral extracted from the ground about it. If a bonanza is large, the amount of barren vein rock about it is correspondingly large. On this account it is not singular that for a distance of 480 feet, the Pastrana tunnel has run in ground giving but slight results, for it runs very close below the old bonanzas. The vein, however, in it, begins to show signs of returning mineral life. These signs are different for different classes of veins, but for the same class of veins in each locality, are identical. In the native silver veins of Batopilas, the first sign of returning mineralization is the appearance of a slight sprinkling of brassy and arsenical pyrites. A little further the pyrites become mixed with flecks of galena. Then the pyrites disappear, and the galena becomes a little more abundant. When a light yellow zinc blende begins to show itself in connection with the galena, it is a sure sign that the next metal that will appear will be silver. Suddenly the galena entirely

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disappears from the vein, or almost so, and closely accompanying the remaining zinc blende is the native silver in larger or smaller concentration (bonanza or bonanzita).

* * * * * * *

ON RESERVE FUND AND WORKING CAPITAL.—The strongest and most advantageous financial position in which a mining enterprise can be placed is by securing to it a reserve fund, always at command. Pressing emergencies continually arise, often of a very temporary character, but sometimes of so grave a nature as to render available funds most desirable, in order to avoid damaging delays. Many a mining company possessing a valuable property, yielding handsome dividends, is hampered in its operations in the most vexatious manner by lack of this provision. Bullion on the road is money tied up, and dividends paid investors is money no longer under control. It is very possible for a company to have product on the road, and to have already paid handsomely and to be about again to do so, and yet to have a treasury so empty as to be unable to meet the ordinary demands of business until the bullion in transit has arrived and has been marketed. A reserve in bank, at command at a moment's notice is an element of power which no well-managed business can afford to do without. The best managed mining companies in both America and abroad consider such a fund as not merely necessary for the prompt transaction of business, but as in the highest degree prudent. The heavier a business is, so much greater is the necessity of promptly meeting ordinary business demands, and if extraordinary demands do arise, both the credit and the future of the business may be saved by having at hand available means.

* * * * * * *

WORKING CAPITAL.—Methods have been detailed of opening the property, and the natural question arises

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as to how much capital should be set aside for the purpose. The following estimates will give some idea of the matter:

1. Rehabilitating tunnel with ties, rails, cars, and fifty feet of close timbering	$6,000
2. Extending tunnel 400 feet	20,000
3. Cross-cuts, and rails for them	5 000
4. Cleaning Sanchez and Marquis shafts, and fitting them with whims, ropes, and buckets	3,500
5. Sinking shafts	10,000
6. Driving levels and raising connection to Cata works	10,000
7. Supplys, rebuilding house at tunnel and Hacienda	10,000
Total	$64,500

This sum should be looked on as dead expenditure. While it is not improbable that some of these works will yield profit while in progress, materially decreasing, or even surpassing the expenditure, it is not good business form to reckon on results not yet attained. As the above sum is unlikely in addition to be sufficient for sudden demands for pumps, or beneficiating apparatus, it would be well to place the working capital at 100,000. Every dollar of this should be paid-up working capital, and all that is not immediately needed should be invested in such Government bonds as bear a low interest, and are easily and quickly negotiable. The attempt to work mines with a working capital consisting wholly of scrip, has been frequently made in the United States, and has not been successful. It is one of the secret causes of many mining failures. When working capital is needed in mining affairs, it is needed in money.

* * * * *

RESERVE FUND.—As it is probable that only a portion of the working capital recommended for this property will be needed to place it in substantial product, it is exceedingly desirable that the residue be held as a reserve fund, in bank, or in quickly convertible bonds. It is also to be recommended that this residue

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be increased from profits to $75,000, and maintained at that figure. Such a reserve should be at the disposition of the Board of Directors for the best interests of the property, and in all cases, where freights, machinery, supplies, salaries, etc., are defrayed from it, such drafts should be replaced out of the very first product. Loss of interest in holding this sum of money in available shape should be considered one of the expenses of the business, and will be fully compensated by the delays to business avoided. A reserve fund of this character is what an anchor is to a ship. It is useful at all times. Not merely is it a permanent fund on which to draw for temporary demands, but in case extraordinary expenses at any time arise, the available money is at hand without appealing to stockholders. Many a good mining property has been saved by its reserve fund while in barren ground, which, without this means of bringing itself back to product, would have gone out of work and have been known as a mining failure. More mining failures have been caused by want of business foresight in this regard, and by general financial mismanagement, than by any other cause. The wisdom of such a provision is proved by the tendency of all Boards of Directors to utilize all profit in the form of dividends, both to make a show and also on account of the blocks of stock they themselves own. It is also wise from the point of view that *profits* can be assessed more readily than discontented stockholders.

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SURVEYING OF MINING CLAIMS IN COLORADO.

BY RICHARD A. PARKER, CIVIL ENGINEER, (S. OF M. 1878.)

As the system of public land surveys is well understood by those engaged in the engineering profession, it would be needless in a sketch of this nature to dwell upon it at any length, and for the purposes of this article it will be found sufficient to accept the divisions as we find them, in ranges, townships and sections.

In the main it will be found that there is no difference in the pre-emption of agricultural or mineral lands as both are described as forming a certain portion of whatever section, township or range they may be located in; in the case of pre-empted timber or agricultural lands, the description is complete when the direct sub-division of a section is given, as, for example, in fig. 1, the shaded area would be described as the south half of the south-east quarter, of the northwest quarter of Section——, Township ——, North (or South) Range ——, East (or West) of ——, Principal Meridian.

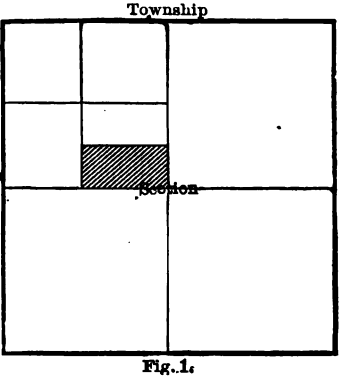

Fig. 1.

In mining districts where aliquot portions of a section are not pre-empted, but claims, consisting generally of rectangles, one hundred and fifty or three hundred feet in width, by fifteen hundred feet in length, a corner of the claim is connected by survey with a corner of the section, and it is thus definitely located.

It is the work of the United States Deputy Mineral Surveyor, to survey and locate claims in reference to section corners. In case sectionising had not

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progressed to the locality wherein a claim has been established, it is tied to a "locating monument," a description of which will be given later on.

The survey for a mining claim consists of two parts—the survey for location, and the survey for patent.

Before a *valid* location can be made, there are a few points it would be well for the engineer to note in his field book, not that they would in any way affect him or his work, but that they form the basis of the majority of lawsuits, and the benefit of a note made upon the ground, and at the time of survey, would be invaluable; they are: whether, first, the discovery shaft is ten feet deep at its *lowest surface* point; second, that there is a true vein exposed, though not necessarily showing mineral; and third, that he has been called upon to survey the claim within ninety days from the date of discovery of the lode or vein, as shown by the discovery or location stake.

Lodes are discovered in all sorts of ways, some stumbled on, some showing clean mineral in place, and others legitimately prospected for; the latter requiring knowledge, energy and pertinacity. The prospector armed with a few days rations, pan, coffee-pot, pick and shovel, a few gads, hammers, etc., starts for some district and commences the ascent of a mountain he may favor; while so doing a close watch is kept for indications or "float-ore," a decomposed ferruginous quartz that has probably become detached from the vein-filling and rolled down the mountain side. This float is the prospector's polar star. Still ascending until all trace of it has disappeared, he feels that he has then passed above the apex of the vein he is in search of, and descends until it is again encountered. Reascending, he continues until the area which probably contains the vein, is narrowed down to a few yards. An adit is run in the mountain side, or a shaft sunk, to determine further the exact location of the vein. If one is found, then a location stake is planted by which ownership is claimed and which

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forms the initial point of the survey. On it is written a notice containing the date of discovery, the name of the lode and its locator, its general direction, and finally the distances to the end lines of the claim. Sixty days subsequent to the date of discovery is given by law, in which the discovery shaft or adit has to be sunk or driven ten feet, and in case no vein matter or wall-rock is exposed, giving evidence of an existing vein at some greater depth; then such shaft must be sunk until the necessary proof is obtained. These sixty days are usually spent in searching for such out-croppings, on or near the surface as will most thoroughly establish the line of the lode upon the ground; as it is of the utmost importance that the latter be accurately determined, in order that the apex of the vein may be contained within the side lines for the full length of the claim, as a second location may be made by another prospector upon the extension of the vein discovered, when found outside of the side or end lines of a claim. Before ninety days have elapsed since the discovery of the lode it must be surveyed and a description of it, with the names of the locators, placed upon record in the county in which the claim was discovered.

Claims are of a uniform length of fifteen hundred feet at present writing, although the widths vary. In five counties, Gilpin, Boulder, Clear Creek, Summit and Park, they are located seventy-five feet on each side of the discovery shaft (supposed to indicate the position of the vein) and in all others one hundred and fifty feet on each side. The discovery shaft must be in the center of the claim in reference to the side-lines, and in no case can the claim be located so that the distance from the discovery to either side-line will exceed the limit of width as placed upon it by the customs of that mining district.

We will suppose the necessary work to be done, and the claim is ready for the surveyor. In case the lode is a straight one, a rectangle of the required width is laid out

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upon the ground, and stakes planted at each corner and at the middle points of the long side lines, each stake being marked with the name of the lode, and "S. E." "S. middle," etc., to indicate its position on the ground with regard to the claim, to enable prospectors who go over the same country to keep outside the lines of this location. Mountain bearings are to be given from at least two corners or points, and for *this* work an ordinary compass will suffice, though for many reasons it is best to use a transit, and obtain true courses.

If, however, a bend occurs in the outcrop, besides planting stakes at the corners and middle points of the side-lines, stakes are to be driven at *each* bend in the survey; thus, in the case of a single bend there would be eight stakes required to properly mark the claim on the ground.

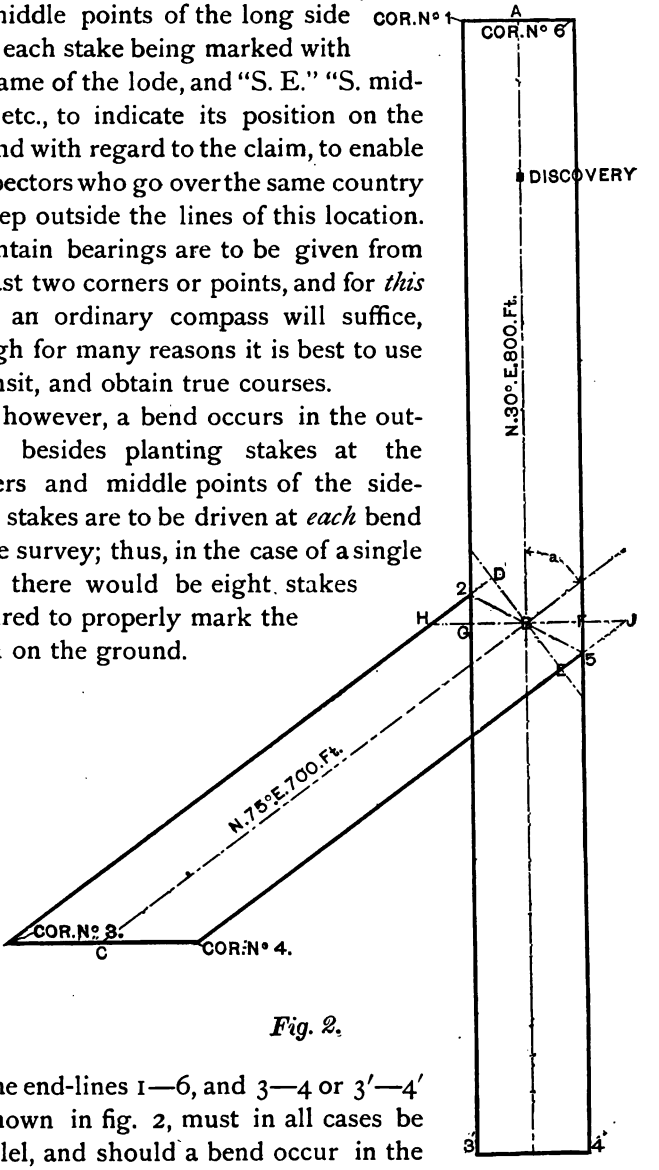

Fig. 2.

The end-lines 1—6, and 3—4 or 3′—4′ as shown in fig. 2, must in all cases be parallel, and should a bend occur in the

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lode, the length of one of the end-lines 3—4 must be calculated in order that the claim have a uniform width. To illustrate this and the method generally adopted for obtaining the lengths of the side-lines, let us take the case of a single bend in the claim as shown in the same figure. Here we have given the course A B say N 30° E, eight hundred feet, and B C, N 75° E, seven hundred feet. Denote the compliment of the angle A B C by a; from the figure it is evident that the side-lines 1—2 and 5—6 are eight hundred feet, and 2—3 and 4—5 are seven hundred feet, plus or minus an increment, it being different in both cases. To determine this increment, through the angle point B draw perpendiculars to the side-lines, the lines F B G and E B D, then will the angle G B D or E B F be equal to the angle a, and E B 5 or G B 2 be equal to ½ a. We now have the line 1—2 equal to A B minus G 2 and 5—6 equal to A B plus G 2, or F 5. But G 2 or F 5 is equal to one-half the claim-width multiplied by the

tan. ½ a or $\left.\begin{matrix}1—2\\5—6\end{matrix}\right\}$ = 800 ∓ ½ W tan. ½ a

and similarly 2—3 and 4—5 are equal to

B C + H D — D 2 and B C — H D + D.

Or, 700 + ½ W tan., a — ½ W tan., ½ a, and

700 — ½ W tan., a + ½ W tan., ½ a, or

$L' = L \pm \frac{1}{2} W (\tan. a \mp, \tan. \frac{1}{2} a)$ in which

L′ is equal to the lengths of the side-lines.
L " " " ". centre "
W " " width of claim.
a " " complement of angle between the centre lines.

Should a number of bends occur in the claim, it is readily seen that the solution of side-lines is entirely similar, and it would be needless to carry the illustration further.

The end-line 3—4 is equal to $\frac{W}{\sin a}$

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If any two alternate courses are parallel then the side lines of the connecting course are of the same length as the course. The stakes for location work are not generally substantial, being posts two or three inches in diameter and of about as many feet in length, and are not intended for permanent use.

When work sufficient to fulfill the requirements of the law ($500) has been done, and the property would seem to justify the additional expense, a patent is applied for to obtain a Government title to the land.

This is done by the owners or their representatives sending a certified copy of the original location as found in the county records, twenty-five dollars and a letter to the Surveyor-General of the State, requesting that an order may be issued to some deputy surveyor to survey the claim. This fee is to pay for the office work necessary in checking the clerical work of the deputy, furnishing blanks, copies of the field notes of the claim surveyed, etc., etc.

Upon receipt of the order to make the survey, the deputy notes the number given to it by the Surveyor General, and proceeds to make the survey, the claim being thereafter designated by its number. Should additional land be required either for milling or timber purposes, it may be preempted with the lode, and all work done upon the latter will be in effect as though done upon the "mill-site," as it is technically called.

In this case a number such as 967 A would designate the lode, and 967 B the mill-site, which must in every case be tied together as often the lode will be found near the summit of a mountain, and the mill-site in the valley half a mile or more distant. The law does not regulate the shape of a mill-site, and its only restriction is that it shall not exceed five acres in area; its survey is in every respect entirely similar to that of a lode-survey as herein described.

The variation of the magnetic needle being so great, ranging from 14° 30′ E to 16° E, and its liability to error

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from local attraction so well known, recourse is made to the solar compass. The old Burt solar which is the basis of every modern one, obtains favor especially with the older surveyors, but the use of a combined solar compass and transit is being rapidly extended. The instruments made by Gurley, of Troy, N. Y., are excellent for general use, but require considerable time to set up, the solar attachment being placed upon the telescope. Those furnished by Young & Son, of Philadelphia, are a decided improvement in the matter of time required for adjusting, and in them the attachment is placed under the plates and removed when not in use. For the method of using a solar transit we would refer the reader to text books or to a handbook issued by W. & L. E. Gurley, of Troy, and will merely give the outline of field and office work necessary to the procuring of a patent.

The fifty feet chain is the principal instrument used for measuring, though there are many places where its use is impossible, and the telemeter takes its place.

The lengths of the side-lines (in case of a bend) having been computed, a meridian is established by solar observation, and the courses and distances are run off on the center line, until an angle point B, fig. 3, is reached; here the instrument is reset, and the line in which the corners lie (2—5) determined, and the corners located at the end of these lines. Corners are preferably either trees, boulders or rock in place, and in case they are not found at the exact point, then stone or wooden posts are to be used. If a stone is used, its dimensions must not be less than $4'' \times 4'' \times 2'$, sunk in the ground one foot and protected by a mound of stones; if of wood, then its minimum dimensions are $4'' \times 4'' \times 4'$, sunk *two* feet in the ground and similarly protected by stones; they should be permanently marked with the number of survey and the corner of claim. A square nail-pointed chisel is used for stones, and a timber scribe for wooden posts. From *each* corner a bearing

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is taken to the nearest natural object, such as stumps, trees, boulders, rocks in place, or any object likely to give permanency to the corner, and serve to fully locate and identify it. If a tree has been used it should be blazed and marked B. T. (bearing tree) together with the number of survey, and if a stone pointer, an X, with the survey number chiseled on it, will suffice.

If mountain or other bearings were given in the original location certificate, they should be verified by solar observation at the respective points from which they were taken. Should it appear that the bearings or courses do not agree after making due allowance for the variation of the needle at that point, then a new certificate of location must be made out, placed upon record and used as a guide instead of the original one.

Close attention must be given to see that the solar survey covers every point embodied in the original certificate, otherwise the work will have to be repeated. It is usual to make in the field-book a diagram of the lode with all details as called for, and verify each point as the survey progresses.

While in the field all improvements, such as shafts, tunnels, drifts, houses, etc., placed upon the claim by the applicant for a patent, are noted with their approximate value and their position in reference to some corner of the claim ascertained. Crossings of roads, fences and creeks are noted, and connecting lines run to the section corner and all adjacent patented surveys as they must be shown upon the plat and field notes sent to the Surveyor General. Should, however, there be no section corner within two miles of the claim, then the Deputy is directed to establish a "locating monument," which consists of a bar of copper or iron, one inch in diameter, inserted in some prominent boulder or rock in place, upon which is chiseled, "U. S. L. M.," for United States Locating Monument, and a name is given it by which it is designated, as "U. S. L. M. Chihua-

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hua." Bearings to trees, prominent peaks, the junction of roads, confluence of streams, etc., are to be given and a full description of it given in the field notes each time it is used to locate a lode.

The plats are made upon mounted sheets of Whatman's paper, which together with blank field note paper, is furnished by the government to insure uniformity. Lodes are platted on a scale of two hundred feet to one inch, with black boundary lines, and the surface colored except in the case of a conflicting claim which has a prior title, the area in conflict being left white. Mountain and all other bearings are in red, with the course of each one plainly lettered. Each corner is marked "Cor. No. 1, Cor. No. 2," etc. The connection from Cor. No. 1, to the section corner is shown as is also the section or quarter-section lines in which the claim is placed.

"If in running the exterior boundaries of a claim, it is found that two surveys conflict, the plats and field notes should show the extent of the conflict, giving the area embraced in both surveys, and also the distance from the established corners at which the exterior boundaries of the respective surveys intersect each other." In notes give area as follows:

Total area	5.16
Less area in conflict with surveys Nos. 967 and 1151	2.00
Leaving net area	3.16

On the plat the net area only is given. The following will give the general form of field-notes at present in use:

Field notes of the survey of the claim of G. G. Jones, on the Porter Lode and Mill Site, situated in Griffith Mining District, Clear Creek County, State of Colorado.

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Survey begun June 1st, 1880
Survey finished June 3d, 1880.

Feet.	
	Beginning at the S. E. cor. Sec. 27, T 3 S. R. 76 W.; thence N. 27° 15′ 39″ W.
	Var. 15° 30′ E.
7462.84	To Cor. No. 1 beginning, a granite post 26″ × 7″ × 12″ in the ground one foot, and protected by a mound of stones, and is marked 1—963 A; whence cor. No. 1, sur. No. 963 B, Porter Mill site, G. G. Jones, applicant, bears S. 27° 16′ 26″ W., 10841.2 ft. distant. Republican Mt. bears N. 10° 12′ E., and Democrat Mt. bears N. 16° 14′ W.; cor. No. 3, sur. No. 840; Pluto Lode, James Gorman, applicant, bears S. 0° 10′ W. 402 ft. A×963A, cut on N. face of boulder bears S. 23° 15′ W. 21 ft.
	Thence S 23° 47′ W.
903.7	To east line of sur. No. 465, Bullion Lode, Colorado Mining Company, applicants, and from cor. No. 5 of Sur. No. 465 to the same point of intersection, S. 34° 21′ E., 87.2 ft.
1069.4	To west line of sur. No. 465, and from cor. No. 2 of same survey, S. 34° 21′ E., 133.4 ft. to the point of intersection.
1243.	To road to Georgetown running N 85° W.
1500.	To Cor. No. 2, a pine post 4″ × 4″ × 4′, marked 2—963 A, in ground two feet, and in mound of stones, whence a spruce tree 16″ diam, blazed and marked B. T.—963 A, bears N. 63° E. 20 ft. Squaw Mt. bears S. 83° E., and Little Chief Mt. S. 74° 30′ E.
	Thence N. 66° 13′ W.
150	To cor. No. 3, a spruce post, etc., etc.

The plat and field notes being finished and sworn to by

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the deputy and those that assisted in marking corners, chaining, etc., they are then sent to the Surveyor-General's office for approval. If any clerical error has occurred, or if it be found by calculation that the connecting lines through the several intersecting lodes to the section corner disagree, then the plat and field notes are returned with a marginal note, as "*out thro' 465 with sec. cor.*," and the error must be discovered and corrected. If the work be right, then it is platted upon the general map of that section of the country, and two approved copies sent to the deputy, with one copy of the field notes; another set of both is sent to the U. S. Land office, for Government use. The patent for the land is now to be applied for, and the furthering of it properly belongs to a lawyer, as may readily be imagined, by glancing over the list of "first" or preliminary papers.

A complete abstract of title.

Certified copy of the pre-emption of lode and mi llsite.

Proof by affidavit of non-mineral character of the mill site.

Affidavit of work done on the lode.

Copy of articles of incorporation of the company, if land is pre-empted by an organization.

Certificate of agency.

Copy of field notes with affidavit of persons assisting on the survey.

Two copies of the plat, (as approved).

An approved copy of same furnished by the Surveyor General.

Proof of citizenship and peaceable possession of claim.

Proof of posting a notice that a patent has been applied for.

But as this paper was intended to give an outline of the method and requirements of claim surveying, it would be tedious to attempt to follow the papers through their official career, and it will suffice to say that it generally consumes a year before the Government titles are perfected.

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The work of claim surveying is not difficult, requiring care alone, and to the young engineer there are few fields that offer inducements at all comparable with Colorado, and especially the lately developed districts of San Juan and Gunnison.

The value of engineers work as *surveyors only* is appended below. General underground or surface work, $10 per day. Locations $6 to $10 each, inclusive of expenses, such as horse-hire and placing the location on record which costs $1.50. Patents cost all the way from $150 to $225, the official fees of which range from $95 to $140, and are of course included in the above estimate.

STEAM ON THE CANALS.

BY CHANDLER D. STARR.

PART I.

The application of steam, in the place of animals, as the motive power for canal boats, has been attempted by innumerable methods during the past century, and yet to-day but a partial success has been reached in the solution of the problem. When we consider how thoroughly steam has supplanted all other motors in traffic on land and the open water, it seems at first sight incomprehensible that the want of the canals should not have been already supplied. Still stranger does this appear when we comprehend how great that want is, and the extent to which the canals have suffered in their competition with railroads, notwithstanding advantages in other directions. A consideration of the relation between traffic by rail and by canal was

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made in France, in 1869. This relation would not be exactly the same at any other place or time, but is sufficiently accurate to convey an idea of the ratios. According to these data, canal navigation requires one-quarter of the dead weight, one-seventh of the traction, one-half of the first cost, one-tenth of the cost of moving stock, and one-fifth of the expense for the maintenance of the permanent way as compared with the movement on rails. These advantages on the side of the water routes should insure them at least the whole of the slow-moving freights, but in many cases the dry routes are able to compete successfully with them in that respect, because of one advantage surpassing all the others—the application of steam. It is apparent from this, that a successful method of applying steam to canal propulsion is of great importance, and would be a marked advance in the march of civilization. An appreciation of this fact has been the incentive to an endless series of plans and inventions.

In applying steam to land travel, only the ground resistence exists, and in open sea navigation, only the water may be used, on the canals both are present. This has led to a greater variety of suggestion in the latter case than in either of the other two, and the inventions assume the characters of both. The large majority of them are vagaries which left the mind of the inventor still-born. Such it would be fruitless to enumerate, and I shall confine myself to those which were either to some extent adopted or else have a bearing on plans at present in use. For convenience in treatment, I shall classify the methods into those acting on the water and those which do not, taking up the latter first. Of these only two of the hundreds of plans proposed (towing by locomotives and the so-called Belgian system) have any practical importance, but a mention of some of the more ingenious may be profitable as showing how thoroughly the conditions have been tested. The inferiority to these of the first class of plans is to be found in the

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great amount of force expended in overcoming the "slip," which invariably exists when the propelling instrument acts upon the water. Immovable resistance may be obtained both on the bottom and the banks of the canal. Attempts to use the bed of the canal as a fulcrum have been made by means of forked poles worked by a crank and acting to push the boat along, and by means of toothed wheels bearing on the soil, or flanged wheels bearing on a submerged rail. The most apparent objection to these is the uneven bed of the canal If this were the only obstacle, it could be profitably leveled, but in no way could it be kept stiff enough to present a reliable resistance. The indirectness with which the power is applied, together with the care and space demanded by the apparatus, are further obstacles in the way of success. It is a prime necessity in the competition with horse boats that the capacity of the boats should be undiminished. The size of the locks limits the dimensions of the boats, and it is evident that any space appropriated to power beyond that required by horses must be taken from the cargo.

A plan going by the name of the "Baker Single Rail" has for some time been before the New York Legislature. It proposes a toothed rail on the bank carrying a flanged wheel attached to the end of a shaft which projects from the bow of the boat, and is operated by a small engine. The shaft is telescoped and jointed, and can be altered to suit variations in the distance of the boat from the shore and in the height of the boat in the water. A similar arm is placed at the stern, with a flanged guiding wheel for the purpose of keeping the axis of the boat parallel to the banks. Any number of boats in tow can by like arrangements be kept in line, and steersmen be dispensed with. The inventor claims that with such a direct and efficient application the power required would be very small. He contemplates a rail on either bank to accommodate boats going in different directions, and auxiliary apparatus at the

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locks by which boats can be hauled into them and out again. This latter arrangement would be of value also to the horse boats.

The application of steam to towage from the bank in a manner similar to the use of horses, is one of the first plans which would suggest itself, and it has been thoroughly tried with results so satisfactory as to give it a place among the methods best worth considering. The towing may be accomplished by road steamers working on an improved towpath, or by locomotives running on a permanent track. A trial to test the efficiency of the former was made on the towpath of the Erie canal, with Williamson's road steamer "Enterprise." It had an upright boiler, was 13 feet long and 7 feet wide, and was provided with a seat in front for the engineer and steersman. It was said to possess 24 horse-power, and was valued at $5,000. There was no difficulty in towing the boats, and with a heavy load the very high speed of four miles an hour was obtained. The experiment was not, however, an economic success, and has never been practically applied. The steamer in question labored under the disadvantage of having an excess of power over that which could be used. The conditions of towage from the bank forbid long tows, and therefore small engines are necessary. When two boats are to be towed in line, the hawser is attached to the side of the first boat, and this turns its bow off shore and gives the boat a sidewise movement, which counteracts the diagonal pull, and the action of the rudder serves to hold the second boat in line. If a third boat be attached, the result is a stern pull on the first, which will draw it in towards the bank in the same way that pulling at the two ends of a string will straighten it. Light traction engines, built for towing not more than two boats, in conjunction with a moderately good road, would come near to meeting the requirements of the problem. They are not, however, as yet financially successful, and the possibility or probability of their

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adoption on canals, is collateral with the success of road steamers in supplanting horses in general use for heavy haulage.

The use of track locomotives has been attempted experimentally on several American canals, where a railroad was conveniently near the canal, but not with satisfactory results. A regular line of locomotive towage has, however, been established on the Bourgogne canal in Belgium. The towpath has been laid with a single rail weighing 5.5 pounds to the foot, and fixed on cross ties placed one metre apart. The locomotive has four wheels, two of which are placed along its axis, one in advance of the other, and the other two are one on either side. The first pair fit into a grooved rail, and are directing wheels, the others have rubber tires and press with a weight of .07 lbs. to the square inch on the Macadamized road, and act as driving wheels. By means of simple mechanism the weight of the machine may be thrown at will on the driving or directing wheels. In the first case the maximum, and in the latter the minimum, of adherence may be obtained to suit the conditions of a loaded or an empty boat. A single road is to be used with relay engines at suitable distances. Each locomotive tows one boat and when a meeting takes place of two traveling in opposite directions, the engines change boats and retrace their paths. They weigh four tons each, and travel at the rate of 3.1 miles an hour with full boats, carrying a cargo of 150 tons.

Endless moving chains and ropes, both on the bottom and banks of the canal, and worked by a stationary engine, have been proposed, but would not be successful, because of the many and sharp curves, the impossibility of keeping the rope on the necessary pulleys, the friction to be overcome, and the frequent changes boats would be obliged to make in passing from one rope to the next.

A method somewhat suggestive of the above, has, how-

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ever, met with marked success—I refer to what, in this country, is called the Belgian System. A rope or chain resting on the bottom of the canal, and secured at its extremities, passes over and is gripped by a wheel on the boat. The revolution of this wheel causes the progression of the vessel, and the rope falls back into the water after its passage. The practical application of this system dates from 1820, and was first made at Lyons on the river Saone, in France. A flat-bottomed craft of 17 feet beam and 75 feet length, was mounted with a wooden platform, on which was erected a windlass. Six horses provided the power, and the motion was communicated from the windlass to the hauling drums, around which the towage rope was wound. After many trials and improvements, a definite system of chain towage was established, such as now exists on the Seine, between Paris, Montereau and the Oise, and on the river Oise. The chain employed is made of .88 inch iron, weighing 7.37 lbs. to the foot and tested to 12 tons. The constant working strain vary between four and five tons. The first steamers were of 16 and 25 horse power, but being insufficient for the purpose, others were built of 40 horse power, intended to go at four miles per hour up stream, and eight miles down stream; these speeds are never attained with a train of barges in tow. One steamer was fitted with engines of 50-horse power, but was found to be unnecessarily powerful. The hold on the chain is obtained either by several turns around two drums or by hooked pulley. Chain towage exists also on the Elbe, between Hamburg and Schandau, a distance of 400 miles. In Russia, on the River Schecksna, and on the upper Volga for 200 miles; on the Oder, the Rhine, and a number of lesser European rivers, and on parts of the River St. Lawrence, in America. In the early days of the system, chain was altogether used. Ropes of flax and hemp were tried, and bars of round iron welded together into one continuous line, but with no good results. At the introduction of wire

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rope a fresh impulse was given, as it was found more fitted to the use than the chain, and it is now to be found on the canals of most European countries, and on the Erie Canal in America. The first line of considerable length on which this was proved practically successful was on the River Meuse, between Liége and Namur, in Belgium, in 1869. The rope is forty-two miles in length, and lies in water from six to twenty feet in depth. Engineers from the principal European governments were present to witness the trial. Later the reports of success which came to this country induced a party of capitalists to send an agent abroad to inspect the works. He made a favorable report, and was instructed to bring back with him the requisite machinery and the lines, and model of a tug for use on the Erie Canal. Experiments were made between Albany and Troy, and in 1871 the New York Steam Cable Towing Company was incorporated. Thirty-one miles of rope were laid between Buffalo and Lockport, and two steamers, the Gov. Clinton and M. M. Caleb, were built. The enterprise was successful, and at present a double line of cable, one for up and the other for down boats, extends from Buffalo to Rochester. The cables are one inch in diameter, of steel wire, with a hemp core. They cost $2,000, and weigh four tons per mile, and have no slack. The two boats are eighty feet long, sixteen feet broad, and draw five feet of water with coal on board. There is a rudder at each end, and a screw at one end four feet in diameter, and seven feet pitch, which is useful in propelling the boats through locks. At the side of the boat are three cast iron wheels six feet in diameter with grooved peripheries. The cable passes under two and over the middle one; the latter is provided with clips, which automatically hold the rope as long as it is in contact with the wheel and prevent slipping. The outside wheels are supported on studs projecting from blocks, which slide in inclined ways and are moved by screws. In this way they can be lifted up and away from

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the clip drum so that the rope originally lying tight in the grove becomes slack and can be thrown over-board by hand when it is desirable to leave the cable. Two sheaves are placed, one at either end of the boat, to support the cable as it is approached and left behind. The drum is fixed on a six inch shaft at the level of the deck, which receives its power from the engine by gearing. The engine is vertical and inverted, and has a fourteen inch cylinder and sixteen inch stroke. The boiler is of locomotive type, and has a shell five feet in diameter and four feet in length.

Such boats, with three or four canal barges in tow, will make an average of three miles an hour, including lockages, against 1.7 by horses and ten miles an hour can be attained on levels when not towing. With the system in complete operation on the canal the average tow is assumed to consist of five boats, carrying 240 tons each, equivalent to 8,000 bushels of wheat to a boat, which is the greatest burden the locks on the Erie canal will permit. The average speed between locks is taken at 3.5 miles an hour and the detentions at each lock one hour, or an average of ten minutes for each boat, including the tug. With double locks such as exist throughout the Erie canal, and with boats alternating regularly up and down, it is believed that the lockages cannot be made in less time; and in cases where no boats require locking in a direction opposite to that in which a tow may be moving, and where each succeeding boat of the tow is compelled to wait the emptying or filling of a lock, the time of lockage would not only be largely increased, but the passage of the tow would be attended by a very serious waste of water. On the other hand, if the system became so well established as to reduce the cost of towing throughout the canal, thereby increasing the traffic, it would become the interest of the State to so enlarge the locks as to accommodate two or more boats at a time. This has been the course of events on the Belgian Canal referred to, and it reacts by removing

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what is perhaps the most serious obstacle in the way of the complete success of the system. The running time between Buffalo and Albany is taken at one hundred hours; adding seventy-two for lockage, we have seven days for the total time between Lake Erie and the Hudson, against ten days by animal power. The time on the Hudson is the same in either case. The cost of a tug is taken at $15,000; interest, repairs, and renewals amount to fifteen dollars a day. The coal consumption is estimated at 2.5 tons in twenty-four hours.

Mechanically there is no doubt of the success of the scheme as the power of the engine is applied almost directly to an unyielding resistance, and the effect produced is from two to three times as great as with a screw propeller. There are five causes for loss of power, but all combined are said not to exceed five per cent. of the force exerted. These are: (1) The friction of the gear. (2) Bending the rope, which amounts to very little with such large pulleys as are used. (3) The loss due to the inclined direction of the rope causing diminution in the horizontal or propelling component and the existence of a vertical component tending to depress the bow. The angle of inclination proved to be 1.13° in towing two 200 ton boats four miles an hour in a canal seven feet deep, seventy-two feet wide at the top, and forty-six feet at the bottom, which is about the section of the Erie. (4) The weight of the lifted cable which has to be borne by the tug. (5) The tendency of the tow-boat to depart from its path because the power is applied at the side. This is counteracted when going empty by a slight movement of the rudder. In towing, a barge may be attached on the same side with the drum, and the tug is thus kept practically straight. Raising the rope from the bottom to the height of the drum, causes no loss of power as it subsequently sinks to the same level.

One of the vital questions in regard to the system was as to the action of the cable and tug where sharp bends were

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to be rounded, but it was found in practice to be unobjectionable. A considerable distance before reaching the curve, the engine suddenly makes a few rapid revolutions as if running without a load. At this moment the rope ahead of the tug is drawn towards the inside shore of the bend, and the slack thus gained falls behind the vessel into the bed of the river. In further approaching the bend and rounding it, the helmsman urges his boat toward the middle of the channel, exerting by the steering power of the steamer a pressure on the rope perpendicular to its direction. This power is small, but is sufficient to draw out the deposited slack, and the tug swings round the bend, laying the rope exactly in the line it has followed. Of course powerful rudders are indispensable, and the rudder at the bow is of service in difficult curves. There may be a load in tow which is too great for its steering power, and in such a case the tug is fixed to the side of the first barge, thus steadying and steering the smaller vessel by the rudder of the large one. It might be and was expected that kinks would be apt to form where the slack was deposited, but with proper care this does not happen. The first few miles from Buffalo, the Erie Canal has a number of extremely short curves. Here the cable is prevented from being drawn on the shore by clusters of piles driven sufficiently far out to insure at all times the requisite depth of water along the line. On easier curves, the weight of the rope is enough to retain it in the bottom of the canal. It is hardly necessary to add that the strain exerted by the tug is not conveyed to the end of the cable, but is balanced in a short distance by the weight of the rope, and its friction on the bed of the canal.

Considering all the facts, the immense advantages arrayed against the few drawbacks, it seems probable that this system of towing is a fair solution of the great problem. "As far as the efficient and economical application of power is concerned, no other mode of steam towing or of steam

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propulsion can ever be expected to compete with it." (D. M. Greene, C. E., State Report, 1874.) There are, of course, manifest advantages in each boat being possessed of its own power, and the greatest of these is the rapidity with which the entrance and departure from locks can be effected, but this arrangement may be considered as economically unfitted for general use on narrow canals, and next to it the Belgian system is perhaps the most advantageous. The greatest obstacle to its universal adoption and one which is incident to tows moved by any system, is the delay to the individual boat when a fleet is to be locked. This is alleviated by reducing the length of the trains, but still remains a serious detraction, because the first cost and running expenses of the tugs demand a number of boats in each tow. The system, however, requires no great or costly alterations in the already existing canal boats, an expense of twenty dollars and delay of thirty minutes, being at the most necessary for altering the steering gear to suit the increased speed. It secures the transportation of freight in one-half the time, at the same or less cost than by animals and does not in any way interfere with the use of the old power when it is desired. The boatmen on the canal approve of it, and the company report their affairs as flourishing. Only one reason exists for doubting its being all that it is represented, and that is the fact that cables were not laid at once throughout the Erie, and the other American canals doing large traffic.

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PROFESSIONAL NOTES.

American Institute of Mining Engineers.—A meeting of the Mining Engineers was held in Philadelphia, Feb. 15–18 inclusive. These meetings are among the most important professional events of the year, and this one was especially memorable and important on account of the large number of papers presented and the wide range of topics discussed. The Institute may well be ranked among the foremost educational institutions of the country—a professional school with distinguished engineers as students and specialists as their instructors! An attendance at the meetings will richly porfit any student of engineering—for not only the subject of the papers, but engineering progress in general finds its way into the discussions. Not merely theories, but actual practical facts. The papers themselves are rarely read entire, but the author in a brief, pithy summary, often more interesting and intelligible than the paper itself, gives an outline of his experience or investigations, and the conclusions derived therefrom. The cut-and-dried printed reports of the discussions give but an imperfect idea of the pleasure and profit of the meetings.

Steel Rails.—The most prominent feature of the meeting was a paper by he chemist of the Pennsylvania Railroad Company, Dr. Chas. B. Dudley, on the wear of steel rails. This paper is the third on the same subject by the author, the first two having been read in October, 1878, attracting much attention, and starting a very lively discussion between the representatives of the manufacturers and the consumers of steel rails. In his paper, Dr. Dudley gave the results of chemical and physical tests of a large number of steel rails, proving that soft steel rails wore better than hard. The following analysis gives the average composition of the best rails tested:

Carbon, ...	0.334 per cent.
Phosphorus, ...	0.077 "
Silicon, ...	0 060 "
Manganese, ...	0.491 "

It is, however, found difficult in practice to produce a steel with so little phosphorus. Dr. Dudley therefore recommended the following specification for adoption by the Pennsylvania Railroad Company in its orders for steel rails, increasing the phosphorus limit slightly, and diminishing the amounts of the other hardening elements:

Phosphorus, not above	0.10 per cent.
Silicon, not above	0.04 "
Carbon, between 0.25 per cent. and 0.35 per cent., with an aim at	0.30 "
Manganese, between 0.30 per cent. and 0.40 per cent., with an aim at	0.35 "
Sulphur and copper, ...	No Specifications.

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Dr. Dudley suggested also that certain physical tests be demanded in addition to the above chemical requirements, tending, however, to the same end, the securing of soft steel for rails.

Observations made by Mr. J. W. Cloud on the wear of locomotive tires, seem to confirm in a striking manner the result of Dr. Dudley's work. The tires, as they come into the machine shop, at Altoona, for repairs, are carefully callipered, and in every case in which the wear of the tires of two drivers on the same axle has proved unequal, it has been found that the soft tire has shown the least wear.

In order to produce steel of the necessary softness, it is not only necessary to have it low in carbon, but to have all the other hardening constituents at a minimum. Silicon is easily eliminated in the converter. Low phosphorus can be secured by using pure irons. A low percentage of manganese is more difficult to obtain.

Effect of Manganese on Steel.—In the discussion which followed Dr. Dudley's paper, the steel makers seem inclined to object most emphatically to having the amount of manganese limited. With so little manganese as 0.35 it was claimed that the ingots would not be sound, and the manufacture of good rails would be difficult.

Manganese is added in the last stage of the Bessemer process, in the form of spiegel or ferromanganese, to get rid of the oxygen dissolved in the iron. It is usual and necessary to add an excess to be on the safe side, as any deficiency shows itself in spongy ingots and poor rails.

A list of analyses was exhibited, of samples of the same steel, with manganese reported by different chemists from 0.3 to 1.2 per cent., tending to show the uncertainties of analytical results. On this point the discussion waxed hot, and one facetious steel maker suggested that in his opinion, "Ananias was the father of chemistry."

Two papers bearing on this subject were read by Mr. S. A. Ford, one describing a rapid and simple method for determining manganese in steel; and the other on a more accurate method of determining the amount of manganese required in the last stage of the Bessemer process to remove the oxygen of the charge.

On the Origin of Gold Nuggets and the Formation of Placer Deposits.—Prof. Egleston, at the meeting of the Mining Engineers, gave a brief summary of an elaborate investigation which tends to prove that the gold of placer deposits may have been concentrated into nuggets by solution in and deposition from water. He finds that gold is soluble in waters containing small percentages of nitrates and other salts representing natural drainage waters, and that this gold is precipitated by the organic matter of soils and gravels.

On so-called Rusty Gold.—In the course of his remarks, Prof. Egleston gave same interesting data with regard to the causes which prevent gold from being amalgamated. After noticing that certain chemicals, such as sulphide of

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ammonium and sulphuric acid, form a film which prevents the gold from being attacked by mercury. He stated that perfectly clean gold, if hammered on an anvil, was brought into a state in which it could not be amalgamated. From this the professor argued that in order to reduce the losses in gold mills, the use of stamp mills, or other crushing machinery acting by impact, will have to be abandoned, and the stamp-batteries replaced by other forms of comminuting apparatus.

Losses in the Plattner Chlorination Process.—In connection with the above paper, Prof. Egleston called attention to the precipitation of metallic gold by organic matter as a source of loss in the chlorniation process; the gold being precipitated by the organic matter in the residues and thrown away.

Education of Mine Bosses.—Mr. O. Heinrich read a very interesting paper on the mining school at Drifton, established by Mr. Eckley B. Coxe, for the training of young working-men for responsible positions about the mines. Coxe Brothers are the largest employers of educated mining engineers in the Anthracite regions, and have deemed it of importance to secure educated mine bosses, to co-operate with the engineers, and to carry their plans into effect. H. S. M.

Poisoning by Carbonic Oxide Gas.—An accident which happened nearly a year ago in France, an account of which has been recently published, is of great interest to all who are likely to be called upon to aid those who have suffered from the accidents of explosions of firedamp in mines, or from the escape of gases from metallurgical or other furnaces. Two or three persons having been killed and several rendered sick by the products of combustion, which passed through a wall into a room where several persons were living, Mr. Meurgey, an engineer of mines, was detailed to make a careful examination of the whole subject. He announced as the result that while making the examination he was both intoxicated and asphyxiated, and that both carbonic oxide and carbonic acid were contained in the gases; that the result of the poisoning by carbonic oxide was first great headache, then loss of speech and fainting; that after recovery of consciousness from the fainting fit, speech was not recovered for several hours, and a number of the phenomena of epilepsy occurred at the same time. This explains what often takes place, for men who have been killed by the explosion of firedamp have been frequently found to have been poisoned by the carbonic oxide and not asphyxiated by carbonic acid, as the air surrounding them was sufficiently pure to allow of their lamps burning, and showing that the men had fallen suddenly while they were running towards a place of safety. Ammonia has been used in blast furnaces for this kind of poisoning, and it has also been found desirable to use very strong coffee afterwards, at the same time applying very energetic rubbing. T. E.

On the Chilling Properties of Iron.—Mr. A. R. Calder published in the Journal of the U. S. Association of Charcoal Iron Workers for January, an

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account of experiments that were made at the Harrisburg car manufacturers on the chillling properties of irons. It was found during a series of experiments lasting over fifteen months, that those irons chilled the most readily in which the iron was only allowed to remain in the ladle until it was perfectly quiet, and was then cast while still very hot and liquid. Iron which under this condition gave half an inch chill, chilled only a quarter of an inch when it was allowed to become as cool as possible without solidifying before pouring, and the latter had only two-thirds of the tensile strength of the ore poured hot. It was found to be affected also by the sulphur in the coal, and it was also influenced by the intensity of the blast. By keeping the stock the same and increasing the blast, the depth of the chill was increased. T. E.

On the Production of Chilling Irons in the Bessemer Converter.—The property of chilling in iron is dependent, to a large extent, on the absence of silicon, and to the presence of carbon, in what has been called the third form, which was first noticed by Karsten between 1830 and 1840. This property of chilling is an exceedingly valuable one, but is found in comparatively few irons. Mr. John L. Gill, Jr., of Pittsburg, has ascertained that by taking any pig and blowing it from four to five minutes in the Bessemer converter up to the point where the carbon begins to burn, the silicon will have been entirely oxidized, and if the converter is turned down at that point, the pig will chill. Experiments were made in the converter with pig, with a tensile strength of 10,000 lbs. to the square inch; after one minute blowing, it went up to 18,000, after two minutes to between 22,000 and 23,000; after three minutes to 25,000, and after four minutes to 27,000, when the iron which previously would not chill, became a good chilling iron. It is greatly to be regretted that further experiments were not made in this direction. T. E.

The true geological age of the metamorphic rocks of New York Island and Westchester County, has long been a subject of controversy among geologists, and still seems very far from a solution which would be universally accepted. The rocks belong to a belt of metamorphosed strata which begins in the northern parts of the Eastern States, continues southward through Massachusetts and Connecticut, passes through New York Island and Staten Island, where it disappears beneath the surface of the ground, and continues in this position across New Jersey to Trenton. Here it again comes into view, and extends at least as far south as North Carolina. Throughout their whole extent the rocks are metamorphic in character, consisting of gneisses and granites, with belts of crystalline limestone, dolomyte and serpentine.

Three prominent theories have been advanced in reference to their age:

First—That they are only another fold of the strata composing the Highlands of New Jersey, and hence Lower Laurentian.

Second—The view advanced by Dr. T. S. Hunt, which supposes them to be Mont Alban, an ill-defined subdivision of the Upper Laurentian.

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Third—The theory recently proposed by Prof. J. D. Dana, in the *American Journal of Science*, 1880, in which he holds that they are highly metamorphosed Lower Silurian strata.

These opinions have each their distinguished supporters, but the weight of evidence is still on the side of the first mentioned and oldest theory, which supposes them of the same age as the Highlands of New Jersey, the Adirondack Mountains and the Canadian Highlands. N. L. B.

The Diamond Drill Used for Stoping.—The only case in which the diamond drill has been successfully used for drilling blast holes, is at the mines of the St. Joe Lead Company, at Bonne Terre, Mo. The success of the experiment in this case is due to the size and regularity of the deposit worked, but more especially to the bold and unique method of stoping adopted. The deposit consists of a *stock-work* or impregnated zone, or "range" in the limestone, about sixty feet thick and in some places one hundred to one hundred and twenty feet in width. This deposit is worked by a system of underhand stoping. A wide heading, about seven or eight feet high, is run in the deposit under the roof, the blast holes being drilled horizontally and at a small angle with the face. After these holes are blasted, other horizontal holes are bored making a greater angle with the face until an opening is made. By succeeding blasts the heading is carried across the face, being interrupted only when it is deemed desirable to leave pillars to support the roof. The chief peculiarity in the driving of this heading or upper bench is in the depth of the blast holes, which instead of being six or eight feet deep as usual, are bored fifteen, twenty and twenty-five feet, effecting a very rapid advance at small cost.

The stoping is carried on by means of vertical blast holes bored parallel with the face of the stope, the drill being firmly mounted on a double column or light frame. The blast holes are also of unusual depth, being drilled the full depth of the stope, or at present about thirty feet. By the use of high explosives, the ore is so far broken up that but little block-holing or sledging is necessary.

The use of blast holes of a depth of twenty or even thirty feet, is not unusual in surface work, especially for blasting in railroad cuttings. Underground, the miners are naturally afraid to use large blasts, and even hesitate to fire many blasts simultaneously, for fear of endangering the safety of the mine; using in fact the same arguments to-day against firing by electricity, that were used by the miners of Germany more than two and a half centuries ago, against the introduction of powder in any form. H. S. M.

Among recent additions to the geological collections may be mentioned Senarmontite from Sonora, Mexico; banded Hematite and Quartzite from the Lake Superior iron region, illustrating the metamorphic character of the iron ore deposits; a beautiful series of clay concretions from the post-glacial deposits of the Upper Connecticut River Valley; fine specimens of the rock "Leopardite," from North Carolina; "Shot Copper," from the Hecla mine, Lake Superior. N. L. B.

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Improved Frue Vanner.—J. M. Adams (S. of M., 1867) has just sent us a pamphlet describing the form of Frue Vanner manufactured under the direction of the firm of Adams & Carter, and sold by them as agents of the patentee for California, Nevada, etc. The new Frue Vanner is in many respects an improvement on the old style, more compact and substantial, and more perfect in its mechanical details.

STUDENTS' DEPARTMENT.

Cotton is now converted into large slabs, and used in architectural work. It is fireproof.

During the last thirty-three years 3,723,182 tons of nitrate of soda have been exported from Iquiqui, Peru.

The cultivation and manufacture of sugar is becoming an important interest in the Fiji Islands, and there are indications that it will soon be their most important export.—*U. S. Consular Reports, No. 3.*

The cochineal crop of the Canaries, in 1879, fell off over one million pounds, or about twenty per cent. from that of 1878; while the price rose about ten per cent.

A considerable deposit of sulphide of antimony (stibnite) has been discovered in Sevier County, Ark. Analyses of the ore show, on an average, 65 to 74 per cent. of antimony.

Mr. E Bede has recommended the use of phosphor-bronze for telegraph wires, instead of iron; phosphor-bronze having four times the conductibility of iron, and being three to four times as strong as steel.

In taking photographs of the photospheric granulations of the sun, J. Janeson obtains a negative image, no image, a positive image, and again, no image, according to the length of time the plate is exposed to the action of light.

De Koninck recommends a ten per cent. solution of potassium bromide as a solvent for bromine, when used as a reagent. It yields a more concentrated solution than water, and is superior to hydrochloric acid in being neutral.

In smelting the Chateaugay magnetite, the only flux used is the slag from a previous operation, and, at times, a little limestone to render the slag more basic. The gangue consists of quartz, feldspar, actinolite, and chlorite.

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Rev. Cowell Brown, of Sheffield, England, proposes to raise submerged vessels by attaching flexible pontoons containing some solid, which on ignition will give a sufficient quantity of gas to inflate them. When large quantities of gas are required, he uses a mixture of coal-dust and nitrate of soda.

M. G. Dupré suggests as a simple way of causing a fire to proc'aim itself, the keeping apart of the contacts of the electric key by a piece of tallow. The heat of the fire would melt the tallow, and cause the closing of the circuit.

Swedish filter paper, treated with a mixture of equal parts of nitric and sulphuric acids, then well washed and dried, may be used in most of the experiments in static electricity. When placed on waxed paper and briskly rubbed, it exhibits energetic action.

Horseshoes are now made of malleable cast-iron. Scrap iron is melted in a Bessemer furnace or a crucible, poured into moulds, and slowly cooled. The cast shoes weigh much less than the common hand-made shoes, they are more durable, and cost considerably less.

Large quantities of steel sleepers are now manufactured at Düsseldorf, and 700,000 tons have been laid in various parts of the continent. It is predicted that the steel sleepers will entirely supersede the wooden ones, as their greater cost is more than counterbalanced by their greater durability.

Dr. Collier, chemist of the Department of Agriculture, at Washington, states that 1,318 analyses, of thirty-eight varieties of sorghum, gave an average yield of 1,662 lbs. of available sugar to the acre. An average of twenty-six analyses of nine varieties of Indian corn, made after the gathering of a large crop of ripe corn, showed the stalks to contain over 900 lbs. of sugar to the acre.

E. A. Neumann, of Düsseldorf, has patented a process for so preparing vegetable fibre that it may be manufactured and dyed with wool, and may be successfully substituted for wool at but a small fraction of the cost. The fibre used is from the rhea plant (Urtica Utilis) known in the United States as wild hemp. (*U. S. Consular Reports, No. 3.*)

By a new process for the preparation of iodine, the juice obtained by fermentation of seaweed is evaporated to a syrupy consistency; the crystalline salts separated from the organic matter by dialysis, and the solution containing the salts of iodine, submitted to evaporation and crystallization. Treatment with sulphate of copper yields iodide of copper, which is easily converted into iodide of potassum.

Gas lighted buoys are coming into use in Great Britain. The gas is stored in the buoy itself, at a pressure of about seven atmospheres, that is, a buoy of a capacity of 150 cubic ft. will give 1,050 cubic ft. of gas, which at 7.10 cubic ft. per hour, will last about six weeks. The gas used is from refuse shale oil, and the estimated cost of lighting is only five cents per twenty-four hours consumption.

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By a new process, worn-out steel rails are cut into suitable lengths, placed on a layer of scrap iron, surrounded with small scrap, placed in an ordinary heating furnace, and subjected to a welding heat. The steel is thoroughly decarbonized and converted into a fine strong fibrous iron, which, when reheated and rolled, is suitable for tires, car-axles, chains, and other grades of iron requiring especial strength and toughness.

The production of pig-iron in the U. S. in 1880 was 4,295,414 net tons, being an increase over 1879 of 1,224,539 net tons, or 40 per cent. Of the total production of pig-iron in 1880, 1,807,651 net tons were made with anthracite coal; 1,950,205 tons with bituminous coal and coke; and 537,558 tons with charcoal. The increase of charcoal pig-iron has increased pari passu with that of anthracite and bituminous pig-iron. Twenty-three States are now making pig-iron. There was also an increase, over former years, in the production of spigeleisen.

Swiss condensed beer is now largely exported to southern countries. It is manufactured by reducing a carefully made beer, in vacuum pans, to about one-twelfth its original bulk. The alcohol, which distills off in the first part of the operation, is put back and the product packed. To prepare for use, water is added to original volume, and the liquid slightly fermented. Thus prepared, it cannot be distinguished from beer made in the ordinary manner. —(*U. S. Consular Reports, No. 3.*)

Malvern W. Iles, (S. of M. '75,) effects a rapid and complete decomposition of slags and silicates, without the use of a blast lamp, by fusing 40 to 50 grammes of pure potassic hydrate in a silver crucible; cooling; then adding one gramme of the powdered silicate, and fusing again for about thirty minutes. His process allows a complete separation of alumina and iron, and an easy determination of manganese, as the results of the fusion are silicate, manganate and aluminate of potash, and ferric oxide.—(*Eng. and Min. Jour., Jan. 22d, 1881.*)

Cotton seed oil is now largely used as an adulterant for olive oil in Italy and France, even in the small villages of the interior. The mixture cannot be detected by any ordinary means, so similar are the oils. This cotton seed oil is mainly exported from the United States, and its cost, even in olive growing districts, is less than one-half that of olive oil; its use is consequently rapidly increasing.

Mr. Moncrieff, F. R. S. A., asserts that if the London gas companies will extract only 3,000—5 000 cubic feet of gas from a ton of coal, instead of 10,000, as at present, they can produce 24-candle instead of 16-candle gas, twice as much tar and ammonia water, and the coke remaining would, as fuel, give 20 per cent. more heat and *no smoke*. He shows by figures that his

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plan would save $10,625,000 yearly, which may be taken as the annual value of London smoke.

Mm. P. Hautefeuille and J. Chappuis submitted a mixture, rich in ozone, to pressure at a temperature of —23° C. At the first few strokes of the piston, an azure blue color filled the tube. As the pressure increased, the color deepened, until at a pressure of several atmospheres it had become indigo blue. At ten atmospheres the ozone remained liquid. The blue color, like the odor, is an essential property of ozone, and it is thought that the color of the atmosphere at great depths may be due to the ozone it contains. (*Sc. Am. Supp.*)

Dr. T. M. Drown, of Lafayette College, gives the following method for the determination of sulphur in metallic sulphides, or in coal. The mineral, very finely pulverized, is treated with a saturated solution of bromine in caustic soda. Hydrochloric acid is added to slightly acid reaction, the solution meanwhile being kept hot. Silica is removed in the usual way, and the sulphuric acid precipitated from the filtrate by barium chloride. Sulphur organically combined cannot be determined by this method.

The causes of unequal coloring of butter are, according to Prof. Selge, *First*—The presence of white or green lumps of cheesy matter, which tend to form when cream is "raised" above a temperature of 12° R. *Second*—Spots or streaks of lighter color throughout the mass, which are caused by excess of buttermilk, or uneven salting, and which may be remedied by reknéading. *Third*—Layers of different colors produced by packing together different colored lots. *Fourth*—Uncleanliness in handling or storing, or sediment in the coloring matter; the remedies of which are evident.—*U. S. Consular Reports, No. 3.*

As the result of a series of experiments made upon common air, are filtered through cotton wool, various kinds of dust, etc., Mr. John Aitkin concludes that water vapor condenses in the atmosphere only on a solid nucleus; that dust particles form the nuclei; that if there was no dust there would be no fogs, mists, clouds, or even rain, and every object upon the surface of the earth would become a condenser upon which the supersaturated air would deposit; that our breath, when it becomes visible, and every puff of steam from an engine, show the impure and dusty state of the atmosphere. The most active fog producers, he says, are sulphur and common salt.

The improvements in the Sprengel pump effected by Prof. O. N. Rood will greatly aid in pushing forward the investigation of the properties of highly attenuated gases, as it secures an attenuation of from $\frac{1}{90,000,000}$ to $\frac{1}{100,000,000}$. In this invention the mercury, instead of being at once inducted into the pump, as heretofore, is passed first through an exhausted bulb, to free it from air and moisture, and then is conducted through a nearly horizontal tube to the fall tube, in which a valve or seal is formed by bending the tube obliquely

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forward, then downward, then upward again. Besides securing greater attenuations, the rapidity of action is increased. (*Sc. Am. Supp.*)

By submitting different gases, vapors, and perfumes to the action of an intermittent beam of radiant heat, Prof. Tyndall has obtained musical notes varying from one as loud as that of an ordinary organ pipe, given by olefiant gas, to a scarcely perceptible note from carbon di-sulphide. The intermittent beam is obtained by rotating a plate of sheet zinc, with radial slits, between the flasks containing the vapor and the source of the beam. The theory is that the intermittent beam produces rapid changes of temperature, accompanied by changes in shape and volume, giving rise to sound waves; and that the loudness of the sound is proportional to the capacity of the gas or vapor to absorb heat.

Dr. Carnelly states that, provided the pressure be kept below a certain critical point, ice may be heated to above the boiling point of water, and completely volatilized without becoming at any time liquid. He exposes thin layers of ice, in a Torricellian vacuum, to the heat of a Bunsen burner, and by condensing all vapors in an attached flask, prevents any appreciable increase of pressure. The result is that, though a thermometer suspended in the same vacuum indicates a temperature as high as 180° C., the ice does not melt, but volatilizes slowly. By dropping 1.3 grammes of the ice into 185 grammes of water, the temperature of the water was raised 0.2° C., indicating a temperature of 122° C. for the ice.

The Farquhar filtering apparatus, designed to furnish an economic system of filtration for the sewage of large towns, has given wonderful resu'ts. The sewage of Asniéres, France, was filtered continuously at an average speed of eight litres per minute, with a filter bed of only 9⅞ inches in diameter, that is, a filter bed ten feet in diameter would filter 260 gallons per minute. The filter bed, composed of sawdust, is suitably supported in a closed vertical cylinder. Through the head of the cylinder passes a hollow spindle bearing a cutter plate, with a radial knife projecting like a p'ane iron. The liquid is forced in through the spindle and distributed over the filter bed. The cutter is rotated, and, gradually descending, shaves off at each revolution a very thin layer of filter bed, which slides up the knife to the top surface of the cutter plate, and leaves a clean filtering surface. When nearly at the bottom, the cutter stops, the filter bed, with the impurities, is removed from the top of the plate, the cutter raised, a new bed made, and the operation continued as before.

The report of the U. S. Commisioners of Education for 1878 has recently been issued from the Government Printing Office. It is a bulky volume of over 900 pages, and full of interesting statistical tables. From it we extract the following items of interest, giving first a table showing the financial cor-

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dition of some of our leading colleges and universities, arranged in order of income from all sources.

	Value of Grounds, Buildings, Apparatus.	Amount of Productive Funds.	Income from Productive Funds.	Income from Tuition Fees.	Total Inc. from All Sources.
Harvard	.....	3,615,539	231,107	120,502	351,609
Columbia	*853,068	4,763,021	217,344	97,787	315,131
Johns Hopkins	.....	3,000,000	180,000	.....	180,000
Yale	.....	1,175,256	42,709	93,221	135,930
College of the City N. Y.	271,147	.....	.....	0	†135,000
University of California	805,000	750,000	105,655	0	†130,655
Ann Arbor, Mich	450,000	.....	38,500	12,455	†124,455
Cornell	912,820	1,263,999	80,000	20,510	†100,510
Washi'gton Univ., St. Louis	300,000	500,000	50,000	30,000	80,000
Lehigh, Bethlehem, Pa.	600,000	1,900,000	76,000	0	76,000
Princeton	800,000	859,000	57,000	18,000	75,000
University of Wisconsin	350,000	483,000	32,388	.....	74,748

The following institutions have incomes above $50,000: Brown, Vassar, University of Minnesota, University of Cincinnati, and Amherst. The following have incomes above 25,000: Dartmouth, Vanderbilt, Williams, Rutgers, Union, Northwestern, Lafayette, Bowdoin, and a few others. The remaining 333 colleges of the country have an average income of $7,145 only.

The total amount invested in grounds, buildings and apparatus, divided among 358 institutions, is $36,871,213, and the total amount of productive funds $37,071,958, a total of nearly 74 millions.

The following table gives a summary of the numbers of students and instructors in universities, colleges and professional schools, omitting students in the preparatory departments of such institutions:

	No. of Institutions.	Professors and Instructors.	Students.
Colleges, etc.	358	3,203	30,36
Scientific Schools	76	523	11,60
Schools of Theology	125	577	4,32
Schools of Law	50	196	3,01
Schools of Medicine	106	1,337	11,83
Female Colleges, etc	225	2,478	23,63
	940	8,314	84,772

Of the students in colleges and professional schools, about 4,000 are women enjoying the advantages of co-education. Of the 225 female seminaries

* At present over 1,000,000.

† Including State support.

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and colleges, about 150 are authorized by law to confer degrees, but not more than half a dozen have incomes above $25,000.

Professional and scientific degrees conferred in 1878:

DEGREE.	No. of Institutions Conferring Degrees.	No. of Graduates.
Mining Engineer	6	36*
Civil Engineer	25	112†
Mechanical Engineer } Dynamic Engineer }	5	35‡
Bachelor of Science	124	990
Bachelor of Philosophy	38	190
Doctor of Philosophy (in course)	11	32
" " " (honorary)	17	31

* School of Mines, Columbia College, 25.

† Rensselear Polytechnic, of Troy, not included. Probably gave degrees to 30 or 40 graduates.

‡ Stevens Institute, 19.

** In some cases the degree of Bachelor of Mining Engineering or Bachelor of Civil Engineering is given. B. M. E. or B. C. E.

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GRADUATE DEPARTMENT.

It is our purpose to give under this head such information as may be of interest to the graduates and old students of the School of Mines; to publish from time to time *correspondence* and *contributions* from those who are actively engaged in professional work; also such personal items connected with the doings and publications of the Alumni of the School, as may be of interest to their professional brethren.

From time to time a corrected list of the graduates, their occupations, addresses, etc., will be given, it being our object to furnish to the graduates of the School of Mines a periodical, which shall not only be an organ wherein results of original investigations can be published, but also a means of binding together the widely scattered members of the Alumni Association; so that the older graduates will learn to know the younger members of their fraternity, if not personally, at least professionally, through our pages.

In this, our object is two-fold; first, the professional advancement of the Alumni of the School; second, the furtherance of that social feeling among the graduates, without which the annual reunions of the Alumni Association would necessarily fail.

In order to carry out successfully the objects above stated, we ask the earnest co-operation of all our graduates, particularly with respect to the following points:

First—To furnish us with original papers, or short descriptive notes, on results of their work in the field and laboratory; items of news, etc., especially such as they may deem of interest to other graduates and to students.

Second—To correct any mistake as to name, occupation or address, by notifying the Resident Secretary of the Alumni Association.

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Third—Should those of the graduates who are advanced in their profession require the services of assayers, engineers, chemists, etc., that they will look for them among the younger members of the Alumni Association, by notifying us of vacancies which may exist, so that the Resident Secretary of the Association can recommend suitable candidates for such positions.

We are glad to note the marriage of the first graduate of the School of Mines, the "Old Man" of the Alumni Association, John Magnus Adams, E M. We extend to him, on behalf of his fellow graduates, our sincere congratulations and good wishes. We hope he will set a good example to the other married members of the association, by regularly attending the annual reunions. We fear that such an example is needed.

We note among the graduates who are actively engaged as consulting Mining Engineers in this city the following: J. C. F. Randolph, 35 Broadway; John A. Church, 115 Broadway; Chas King Gracie, 115 Broadway; W. H. Van Arsdale, 53 Seventh St.; Arthur F. Wendt, 17 Cedar St.; Wm. A. Hooker, 120 Broadway; Arthur Macy, 35 Broadway.

This speaks well for the development of reliable mining industries.

During Prof. Newberry's absence in the West, Mr. J. C. F. Randolph is giving some exceedingly interesting lectures to the the fourth year students on the geology of the gold and silver regions of Mexico and the West. His report on the Pastrana mine, Batopilas, Mexico, is of great interest, and we recommend it to the attention of graduates interested in field work. A few extracts from this report will be found in this number.

It is said that Prof. H. S. Munroe, has received a call to the chair of Mining Engineering in another institution. While we congratulate Prof. Munroe upon the offer, we sincerely trust he will decide not to accept it.

The annual reunion of the Alumni Association took place at the Union Square Hotel, January 5th, 1881. A large number of graduates were present to welcome Prof. Newberry, the invited guest of the evening. The affair was an entire success. We publish the ménu, as a tonic to the members of the association who have not paid their dues for 1881. We trust they will read it, brace up, and do so at once.

MENU.

Everything unknown to us we suppose to be magnificent.—*From the Latin.*

Eozoic.—Carbo hydrates and oleo-margarine.

Silurian.—Ostreæ boreali on their dextral valves. *Vinum xericum*

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SEDIMENTARY.—Bisque de Venus mercenaria. Meat Extract á la Horb.

EXAMPLES IN BOTANY AND ZOOLOGY.—Lycopersicum esculentum. Raphanus satívus. Olea Europœa. Clupea pilchardus in Oleates.

DEVONIAN.—Filet de Labrax lineatus à la Bordelaise. *Vinum album.*

MAMMALIAN.—Filum Bovis tauri à la Macédoine.

ZOOLOGICAL.—Cotelettes de Phasianus Colchicus à la Pèrigord. Ris de Vitellus piquè à la Toulouse. *Vinum Rubrum.*

BOTANICAL.—Pisum sativum à la Français. Brassica oleracea. Solanum tuberosum, Parisiennes.

GLACIAL.—*Horn*blendic Boulders.

CARBONIFEROUS AND TERTIARY.—Ortyx Virginianus on Calcined Carbo-hydrates. Anas boschas. Lactuca sativa.

AGE OF MAN.—Conglomerate à la Godard. Evidences of Glacial Period. Gelatine au Vin de Madére. Organic (C plus H plus O plus N). Remains.
Mumm—i-e—Extra Dry.

HISTORICAL.—Pyramids and Obelisks à la Cleopatra.

NINTEENTH CENTURY.—Caffeine. Saccharose, and Extractum Bovis tauri. Nicotine *Spiritus Vini Gallici.*

"He picked something out of everything he read."—*Pliny.*

APPOINTMENT OF OFFICERS FOR 1881. TOASTS. MUSIC.

"We won't go home till morning."—*Champagne.*

The following letters, among others, were read by the Secretary, at the dinner. The telegram from Leadville unfortunately did not arrive till afterward, too late to be read.

LEADVILLE, Dec. 20th, 1880.

I regret very much not being able to attend. There is a movement on foot with some of the graduates here to have a little dinner by ourselves, and be with you in spirit(s) on the evening of the 5th. There are twelve or fifteen graduates in Leadville. F. E. B.

LEADVILLE, COL.

When does the School of Mines Alumni's dinner come off? There are now sixteen School of Mines boys in and about Leadville. We are thinking of having a dinner here at the same time.

There are also a very large number of Frieberg men in the camp, who pull together remarkably well, and they help each other at every possible turn. The dinner will have the effect of making the School of Mines boys know each other better, learn the addresses of each other, and in various way tend to make us more united for mutual aid.

I will give you the names and addresses of such of the School of Mines men as I can think of who are located near this camp:

J. F. Bateman, Assayer for Taylor & Branton, Amal. Works.

W. S. Duval, P. O. Box 2707, Sup't Bob Ingersoll Shaft.

Arthur B Litchfield, Superintendent Silver Cord Combination.

E. C. Koch, P. O. Box 2649.

Fred. Bruckmann, Assayer, Amie Consolidation.

Theodore Van Wagenen, Superintendent Amie Consolidation.

Chas. M. Rolker, Superintendent Chrysolite Mine.

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Fred. E. Bruen, Superintendent Galespie & Ballou Sampling Works.

Henry G. Clark, Surveyor and Draughtsman to the Silver Cord Combination.

Frank S. Helleberg, Assayer and Chemist, Cummings & Finn Smelting Works.

Ralph Nichols, Page, Nichols & Co., Mining and Civil Engineers, Harrison Ave.

Robert Booraem, Assistant Superintendent Evening Star.

Anton Fernekes, Chemist, Billings & Eilers, Smelting Works.

Leo. Cloud, Assayer, Kokomo.

W. S. Ward, Superintendent Evening Star. M. W. I.

TELEGRAM.

LEADVILLE, Col., Jan. 5th, 1881.

To Columbia College Boys, Union Square Hotel, N. Y.:

Absent members drink your health in Leadville to-night.

ILES & BRUEN.

SAVANNAH, Ga., Jan. 3d, 1881.

Dear Sir:—From Savannah's green avenues I drop these lines to send the news, that note and notice about dues, though tending to produce the blues, have duly been received.

Though the pen and the muse, unaccustomed to use, you will never refuse to accept my excuse, for staying away to-night. I wish to the deuce, three days I could lose, through fields of bright hues, in a Pullman car snooze; and dine with you all to-night. But alas, it's no use, my hard fate to abuse, it would only amuse, so with kindest adieux, I wish you all a *Jolly Good Time.* Very truly, yours, K. N., '79.

The officers of the Alumni Association for the coming year, are: *President*, Archibald MacMartin, '68; *Vice Presidents*, Elwyn Waller, '70, A. F. Wendt, '72, F. N. Owen, '78, N. Hathaway, '79, J. G. Mattison, '80; *Secretary*, H. S. Munroe, '69; *Treasurer*, W. E. Hildreth, '77; *Resident Secretary*, P. de P. Ricketts, '71.

We are informed that the Resident Secretary of the Alumni Association, in his official capacity, has obtained, since October last, positions for some fifteen of the graduates of the School. Indeed the demand for graduates is such that nearly every member of the class of 1880 has been able to obtain employment in some branch of his profession. The class of '81 should profit by the above, join the Alumni Association immediately on graduation, and keep the Resident Secretary posted as to their addresses, etc.

It is proposed to furnish to graduates of the school, and to such fourth year students as apply, badges in the respective courses of Mining Engineering, Civil Engineering, and Chemistry; these badges to be conferred by the Alumni,

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Association, only upon students who are without conditions, and will agree to forfeit the badge if they do not graduate. Each badge to be marked with the initials of the receiver, the year of graduation, and a running number in order to identify the badge. The object of the association is not to make the professional badges less difficult to obtain, but to have them serve as the official sign of membership in the Alumni Association. We understand that the committee of graduates in charge of this matter are having a very handsome engineering badge prepared, somewhat different from that now worn by students and graduates, inasmuch as it will be a closer representation of the ancient "*schlägel und eisen.*"

It is said that a movement is on foot to organize a branch Alumni Association in Leadville, Colorado. The following correspondence will perhaps explain this matter more fully than we can do at present. It seems to us that the idea is a good one, provided that the Association mentioned shall not be a separate organization, but that the Alumni Association establish a Western headquarters at Leadville, in charge of the graduates located in that city.

LEADVILLE, Jan. 7th, 1881.

Dear Sir:

On the fifth day of this month, a dinner was to have been held, in this city, by a number of graduates of the School of Mines, Columbia College. The dinner did not come off, but a meeting was held in which it was proposed to found a branch association out West, since the members out here were rather too distant to attend the meetings of the alumni association in New York, to which your invitations cordially invite us.

Following are the minutes of the meeting relative to this subject:

Meeting called to order at 8½ P. M., Mr Van Wagenen in the chair. Motion made by Mr Bruen, to establish an organization of the Alumni of the School of Mines, Columbia College, in the West, *subject to approval* of the Alumni Association in New York, headquarters to be in Leadville. Object in view:—The institution of social gatherings, and to make the members of the association out here better acquainted with each other. Carried.

Motion by Mr. Bruckman, that the secretary notify all such graduates who may be within traveling distance of Leadville, that preliminary organization has been affected, and that they be requested to let the secretary know whether they will act with us. Carried.

Motion by Mr. Bruen, that as all business has been finished, we adjourn to Conrad's private room, and drink the health of the members we are unable to join this evening. *Unanimously carried.* Meeting adjourned subject to call of secretary.

I was requested to send you a copy of the minutes, and to inquire whether there were any objections to our establishing what may be called a "Branch Association."

There are in Leadville (or shortly will be) fifteen graduates of the school;

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some in Georgetown, in Gunnison, and in other places in the State. All in all perhaps two dozen, so that we are quite a formidable crowd. If you desire it, I will make as complete a list as possible.

By answering at your earliest convenience you will greatly oblige,

Yours respectfully,

E. C. KOCH, '79, Secretary.

Dr. P. de P. RICKETTS, *Secretary Alumni Association.*

COLORADO SPRINGS, Col., Jan. 15, 1881.

How did the dinner go off? Write me all about it when you have leisure, and tell me who were there and what was done. I thought of you at the time, and wished I could be with you. I hope I have not seen the last of the meetings of the Alumni of the School of Mines. I am very pleasantly situated in one of the pleasantest towns in America, but it will not quite take the place of New York. This is a very lively State, and there are plenty of chances to make money, but then there are plenty of chances to lose it. Fortunes are not lying around loose, as many suppose, but a great deal of hard work has to be done for them. Still, there is a better chance for a young fellow than in the East; but he must be a pushing, energetic fellow.

G. H. P.

TUSKEEGO, Iowa, Jan. 12, 1880.

Since calling on you at the School of Mines, I have embraced an opportunity of becoming one of the corps of engineers on the Chicago, Burlington & Quincy R.R. Have our headquarters at Burlington, Iowa. My duties are mostly in the field, returning to the office only to partially plat our surveys. Expect to remain here for some time. Like it much. Our work is obtaining the topography of the country in certain places near line of road, with a view to improving grade, also running old lines, putting in side tracks, etc. Many of our Eastern boys are here. One of the '78 men of S. of M., whose name has slipped me, is connected with the road as a chemist at Aurora, Ill.

J. T. B.

TOMBSTONE, ARIZONA.

Tombstone is quite a camp; it has about 3,000 inhabitants. The population is rapidly increasing, and it bids fair to be a city of 10,000 before many months. There are some very good mines here, notably the Contention, Grand Central, Head Center, Sulphuret, the Tombstone Company's group, Vizina and Sunset. I might string out the list indefinitely, but the ones mentioned are among the more prominent. The ore as a rule is free milling chlorides, carry very often high per centage of "horn" silver. I have seen none, but parties have told me that they sometimes get sulphide and native silver. The "Contention Group" have what appears to be a contact vein in the Contention Mine; they have sunk on it about 400 feet, with a better show-

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ing as developments progress. The Company paid $100,000 for the Contention mine, now it has several *millions* in sight.

The Tombstone and Vizina Company's mines as yet are only blanket veins, the surface deposits they have uncovered are a big thing, but it yet remains to be seen what they will amount to. E. C. VAN B.

MEXICO.—A letter just received from a recent graduate of the School, contains so much that is of interest, that we may be pardoned for making liberal extracts from it. He announces in his letter that he has just accepted the position of Mining Engineer and Metallurgist to two mining companies, but modestly disclaims ability to fill so many positions at so many mines alone, and hopefully looks forward to the time when he can invite a squad or two of men from 1881 or 1882 to join him. Speaking of his work at one of the mines, he says:

"I first ran a line of levels seven miles long, to ascertain how far the water could be carried from a river by natural flow for the reduction works. I had no engineer's level, so used my transit. I ran a second line, and the two checked within an inch and three-quarters. Will Prof. Munroe accept that result? I then had to make plans and calculations for a dam across the river. The width of river is 261 feet, and the dam will be about twelve feet high; quite a respectable dam, you see. Then I had to run a line connecting the front of a tunnel with some old works which it is designed to cut. The mines have been worked in chamber deposits in a limestone formation, and are somewhat irregular, as you can imagine. Some of the chambers are enormous (large enough to put the New Cathedral in), and these are connected by galleries, generally very low and tortuous. Sometimes I could take a sight only a few feet long, and often had to set up the transit in places not two feet high. I took about fifty sights in running in half a mile from the mouth."

At the other mine, his work is principally in the treatment of ores, for which both smelting and lixiviation are used. At present they are not concentrating at all, but eventually they propose to do so.

"Our ores here are of a very mixed character, containing galena, blende, sulphurets of antimony, copper, iron, etc, in a quartz gangue. We have some grey copper which carries $2,000 to the ton; this is treated directly on a lead bath in the refining furnace. The smelting ore contains $200 and upwards, and the milling, or lixiviating ores, run from $50 to $100 per ton. We roast in reverberatory furnaces having four consecutive hearths, and lixiviate by the Von Patera process, except that we use the thiosulphate of lime instead of the corresponding salt of soda The smelting is done in very small adobe furnaces, and the ore is charged in crude state I am anxious to replace these with modern furnaces as soon as possible, as the expense is heavy and output small.

"I have had some trouble with the miners. At first I only had Mexican foremen, and they allowed the men to point the holes very badly, and did not equire them to make them deep enough; then I got a German foreman, and

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when he would not grant them full pay till their work was done, they all left, and no work was done in the mine for a week; but yesterday he got some new men and commenced again; but this morning, when he was going into the mine, he slipped on one of these Mexican ladders (which he says was greased for him) and fell nearly a hundred feet down ladders, and from one offsett to another. One of his arms is broken, and the poor fellow is badly bruised, but I hope he will get up again." F. D. B.

LIST OF GRADUATES.

1867.

John Magnus Adams, A.B., A.M., E.M., Mining and Mechanical Engineer, Agent for Frue Vanner, etc., 109 California Street, Room 7, San Francisco, Cal.

Samuel Willard Bridgham, E.M., 49 West 23d Street, New York City.

Francis Gordon Brown, E.M., Merchant, 116 East 27th Street, New York City.

Edward Stelle Brownson, A.B., A.M., E.M., Prospect Park, Brooklyn. House, 144 Hicks Street.

John Adams Church, E.M., Ph.D., Consulting Engineer, 115 Broadway, New York City.

Henry Bedinger Cornwall, A.B., A.M., E.M., Professor of Analytical Chemistry and Mineralogy, College of New Jersey, Princeton, N. J.

Edward Everett Giddings, E.M., Merchant, 21 Metropolitan Block, Chicago, Ill.

Charles King Gracie, A.B., E.M., Consulting Engineer, with J. A. Church, 115 Boreel Building, Broadway, New York City.

Albert Ward Hale, A.B., A.M., E.M., Civil and Mining Engineer, 71 Broadway, New York City.

Thomas Hayes Harmer, A.B., A.M., E.M., 113 East 37th Street, New York City.

Frederic Milton Heath, (formerly Petit,) E.M., Potsdam Street, Lawrence County, N. Y.

William Wey Tuttle, E.M., Horticulturist, care of Baird & Tuttle, Bloomington, Ill.

David Van Lennep, E.M., County Surveyer and Assayer, Winnemucca, Humboldt County, Nevada.

1868.

William Henry Van Arsdale, A.B., A.M., E.M., Consulting Engineer, 53 Seventh Street, New York City.

Augustus Porter Barnard, E.M., Civil Engineer, 28 West 20th Street, New York City.

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George Strong Baxter, A.B., E.M., Mining and Civil Engineer, Cashier, North Pacific Railroad, 23 Fifth Avenue, New York City.

James Pettigrew Carson, E.M., Mining Engineer; address, 63 Fifth Avenue, New York City.

Albert Huntington Chester, A.M., E.M., Ph.D., Childs Professor of Agricultural Chemistry, Hamilton College, Clinton, Oneida Co., N. Y.

George Hampton Coursen, E.M., C.E.

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Archibald MacMartin, A.B., A.M., E.M., Editor and Metallurgist, 168 Fifth Avenue, New York City.

Edward Stewart Moffatt, A.B., A.M., E.M., Superintendent of the Musconetcong Iron Works, Stanhope, N. J.

George Howland Parsons, E.M., Superintendent of the Land Improvement Company, Colorado Springs, Col.

William Pistor, E.M., Instructor in Drawing, School of Mines, Columbia College; address, 211 West 44th Street.

Charles Slason Platt, E.M., Assayer, 4 Liberty Place, New York City.

Kenneth Robertson, E.M., Superintendent of the Missouri Furnace Company; address, care of Potter & Riggs, St Louis, Mo.

Albert P. Shack, E.M., Student of Divinity, 24 Somerset Street, Boston, Mass.

Frederick Agustus Schermerhorn, E.M., Trustee of Columbia College; address, 61 University Place New York City.

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William Allen Smith, E.M., Manager of the Weldon Mining Company, Dover, N. J.

Frederick Stallknecht, E.M., Editor, 133 West 13th Street, New York City.

Moses Dillon Wheeler, A.B., E.M., Assayer to Lyon Mill and Mining Company, Dayton, Nevada.

1869.

* Thomas Monahan Blossom, A.B, A.M., E.M. Died, October, 1876, in California.

Frederick Bruckman, E.M. Assayer to the Amie Consolidation Company, Leadville, Col.

Alonzo Clarence Campbell, E.M., Chemist and Mining Engineer, 227 Shelby Avenue, Nashville, Tenn.

William Augustus Hooker, A.B., A.M., E.M., Consulting Geologist and Mining Engineer; office, 120 Broadway, New York City.

Roland Duer Irving, A.M., E.M., Ph.D., Professor of Geology and Mineral-

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ogy in the University of Wisconsin, Assistant State Geologist of Wisconsin, and Special Agent of the Tenth Census of Exploration of Lake Superior.

Walter Proctor Jenney, E.M., Ph.D., Consulting Engineer and Geologist, Deadwood, Dakota.

Henry Smith Munroe, E.M., Ph.D., Adjunct Professor in Surveying and Practical Mining, School of Mines, Columbia College.

Lionel Robert Nettre, E.M., Superintendent of the Gregory Cons. Mining Company, Helena, Lewis & Clarke Co., Montana.

* Henry Newton, A.B., E.M., Ph.D. Died, August 5th, 1877, at Deadwood City, Dakota Territory, while occupied as Assistant Geologist of Black Hills Expedition.

William Bleecker Potter, A.B., A.M., E.M., Professor of Mining and Metallurgy, Washington University, St. Louis, Mo.

John Cooper F. Randolph, A.B., A.M., E.M., Consulting Engineer, 35 Broadway, New York City. 11

1870.

Ogden Haight, E. M., Stock Broker, Broadway, New York City.

William Halsey Ingersoll, A.B., A.M., LL.B., E.M., Assistant in Mechanics and Astronomy, Columbia College.

John Augustus Knapp, A.B., A.M., E M., General Manager Mingo Furnace, P. O. Box 515, Salt Lake City, Utah.

John Leo Lilienthal, E.M., Brewer, San Francisco, Cal.

Stuart Lindsley, E.M., Assayer and Analytical Chemist, Chrysolite Smelting Company, Leadville, Col.

Edward Moore Parrot, E.M., Manager of the Furnaceville Iron Company, Furnaceville, Wayne County, N. Y.

Richard Henry Terhune, E.M., Superintendent of the Morgan Silver Smelting Company, Salt Lake, Utah.

Theodore Francis Van Wagenen, E.M., Superintendent of the Amie Consolidation Company, Leadville, Col.

Elwyn Waller, A.B., A.M., E.M., Ph.D., Instructor in Analytical Chemistry, School of Mines, Columbia College, and Chemist to the New York Board of Health, New York City. 9

1871

William E. S. Fales, E M., LL.B., Lawyer, 359 Fulton Street, Brooklyn, N. Y.

Samuel Anthony Goldschmidt, A.B., E.M., Ph D., Chemist; address, 59 Liberty Street, New York City.

John Gordon, Jr., E.M.; address, care E. Johnston, Rio Janeiro, Brazil.

Pierre de Peyster Ricketts, E.M., Ph.D., Instructor in Assaying, School of Mines, Columbia College.

George Washington Riggs, Ph.B. (Chem.), Chemist, Potter & Riggs, Washington University, St. Louis, Mo.

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Gracie Sayre Roberts, E.M., C.E., Consulting Civil Engineer, 88 Union Avenue, Brooklyn E. D.

Richard Spotswood Robertson, Jr., E M., with Edgar Thomson Steel Co., Pittsburgh, Pa.

1872.

Peter Townsend Austen, Ph.B. (Chem.) Assistant Professor of Analytical Chemistry, Rutgers College, New Brunswick, N. J.

* Frank B. Jenney, E.M., died in Trinidad, 1876, while engaged as Superintendent of the Orinoco Exploring Company.

Frederick H. McDowell, E.M., Contractor and Engineer, 17 Cortlandt Street, New York City.

Thomas O'Connor S'oane, A.B , A.M., E.M., Ph.D., 55 Pine Street, New York City.

Arthur F. Wendt, E.M., C.E., Consulting Engineer, 414 East 51st Street, New York City.

1873.

Frederick A. Canfield, A.B., A.M., E.M., Consulting Engineer, Dover, New Jersey.

Charles Adams Colton, E.M., Assistant in Mineralogy, School of Mines, Columbia College.

Henry Augustus Mott, Jr., E.M., Ph.D., Mining Engineer, and Analytical Chemist; office, 105 Water Street; residence, 30 West 59th Street.

Henry Walter Webb, E.M., Lawyer, Webb & Sprague, 206 Broadway, New York City.

John Townsend Williams, E.M., Ph B., East River Chemical Works, 44th Street and East River, New York City.

1874.

Charles Sumner Allen, Ph.B., M.D., Practicing Physician, 104 East 85th Street, New York City,

William de Liesseline Benedict, E.M., Assayer and Analytical Chemist Germania Station, Salt Lake, Utah.

John Gedney Mott Cameron, E.M., C.E., Assayer, Spears & Howard; address, 55th Street, and Madison Avenue, New York City.

Samuel Morris Lillie, E M., Chemist, Harrison, Havemeyer & Co., 101 South Front Street, Philadelphia; residence, 307 Pine Street, Philadelphia.

George Murray, E.M., 235 West 23d Street, New York City.

Eben Erskine Olcott, E.M., Consulting, Mining, and Met. Engineer, 111 West 13 Street New York City.

Benjamin Franklin Rees, E.M., Merchant, 37 Ferry Street, New York City.

Francis Bell Forsyth Rhodes, E.M., Mingo Works, near Salt Lake, Utah.

Frederick Harrison Williams, E.M., Superintendent Cummings & Ferrin's Smelting Works, Leadville, Colorado.

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1875.

Magnus C. Ihlseng, E.M., C.E., Assistant in Physics, Columbia College.

Malvern Wells Iles, Ph.D., Assayer, Grant Smelting Works, Leadville, Col.

Charles Edward Jackson, C.E., Division Engineer Manhattan R R. Co., 60 Gold Street, New York City.

Douglas Arad Joy, E.M., Assistant in Chemistry, University of Michigan, Ann Arbor, Mich.

* Robert Schuyler Lamson, C.E., Major in the Egyptian Army, died at Darbour, Upper Egypt, 1876.

Harry Wenman Leavens, E.M., U. S. Geological Survey; address, San Francisco, California.

Arthur Macy, Ph.B. (Chem), C.E., Consulting Engineer, 25 Broadway, New York.

William Skaats Noyes, E.M., Assayer in charge of Bodie Mill, Cal.

Philip Charles Pfister, E.M.

Franklin Pool, E.M., Chemist, Celluloid Manufacturing Company, Newark, N. J.

Bayard Taylor Putnam, E.M., Expert U. S. Geol. Survey; address, 182 Fifth Avenue, New York City.

John Krom Rees, A.B., A.M, E.M., Professor Mathematics and Astronomy, Washington University, St. Louis, Mo.

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John Henry Tucker, Ph.D., Chemist, C. W. Durant & Co., Sugar Refiners, 426 E. 24th Street, New York City.

1876.

Thomas Septimus Austin, E.M., Supt. Smelting Works, Germania Station, Salt Lake, Utah.

Frederick Everett Bruen, E.M., C.E, Supt. Galespie & Ballou Sampling Works, Leadville, Col.

Francis Sanderson Craven, E.M. C.E., Assayer and Surveyor, Irwin, Gunnison Co., Colorado.

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Robert William Hall, E.M., Mining Engineer, 3 W. 56th Street, New York City.

Schuyler Hamilton, Jr., A.B., A .M., E.M., Architect, 40 Exchange Place, New York City.

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Walter Lowrie Hoyt, E.M., C E., Chemist and Assayer, Omaha Smelting and Refining Company, Omaha, Neb.

Frederick Furneaux Hunt, E.M., C.E , Tueson, Arizona.

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Elbert Champlin Van Blarcom, C.E., Tombstone, Arizona.

Augustus Clark Walbridge, E.M., C.E., 71 Downing Street, Brooklyn, New York.

James Robert Wardlaw, C.E., Village Engineer, Castleton, Staten Island.

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1877.

Louis de Souza Barros, C.E., E.M., San Paulo, Brazil.

James Thom Beard, E.M., C.E., 103 St. James Place, Brooklyn.

Edward Behr, C.E., 261 Pearl Street, New York City.

Charles Ramsay Buckley, A.B., A.M , E.M., Esmerelda Mine, Black Hills, Dakota; 34 Wall Street, New York City.

Linus Bertram Cady, E.M., C.E., Agent Dunn's Mt. Mine, and Treas. Chatham Mining Co., Salisbury, North Carolina.

Augustus Cass Canfield, E.M., 60 West 54th Street, New York City.

John Britton Cauldwell, C.E., 39 West 28th Street, New York City.

Henry Gilbert Clark, E.M., C.E., New Brighton, Staten Island, New York.

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Charles Louis Constant, E.M., C.E., Assistant in Assaying S. of M. C. C. 141 East 48th Street, New York City.

George Birdsall Cornell, E M., C.E., Civil Engineer, 46 West 48th Street, New York City.

Frederick William Floyd, E.M., C.E., U.S. Geographical Survey, 1813 F Street, Washington, D. C.

Frank Stuart Helleberg, C.E., Assayer and Chemist, Cummings & Finn Smelting Works, Leadville, Colorado.

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Axel Olaf Ihlseng, B.S., E.M., C.E., Chemist, Sugar House of Havemeyer Brothers & Company, Brooklyn, E. D.

José Nabor Pacheco Jordão, C.E., E.M., Ph.B., San Paulo, Brazil.

William Kelley, A.B., E.M., 9 West 16th Street, New York City.

James Buckton Mackintosh, E.M., C.E., Hon. Assistant in Metallurgy, School of Mines, Columbia College.

John Glenvil Murphy, E.M., C.E., Superintendent, Esmeralda Mine, Black Hills, Dakota.

Ralph Nichols, E.M., C E., Nichols & Dunham, Leadville, Colorado.

Dudley Hiram Norris, E. M., Law Student, 112 Lafayette Avenue, Brooklyn.

* James Robert Priest, E.M., C E., School Teacher and Surveyor, Greenville, Sinon Co., Liberia, Africa Died 1880.

William Henshaw Radford, E.M., Richmond Mine, Eureka, Nevada.

Sylvanus Albert Reed, A.B., E.M , Gunnison Crushing and Sampling Works, Rose, Reed & Co., Irwin Gunnison County, Colorado.

Charles Louis Rogers, E.M., C.E., Assayer, Bonaparte Mine, Rocky Bar, Idaho.

Edward Eugene Sage, C.E., Assistant Assayer, United States Assay Office, New York City.

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William Henry Smeaton, C.E., Resident Graduate, 233 East 81st Street, New York City.

Roland Mulville Smythe, E.M., C.E., 539 Henry Street, Brooklyn, New York.

Arthur Thacher, E.M., C.E., Progress Mining Company, Lower California; address, 108 East 36th Street, New York City.

Robert Ward Van Boskerck, C.E, Artist; studio, 337 Fourth Avenue, New York City.

Cornelins Read Waterbury, C.E., Engineer and Surveyor; care of Leonard & Company, 150 Broadway, New York City. 31

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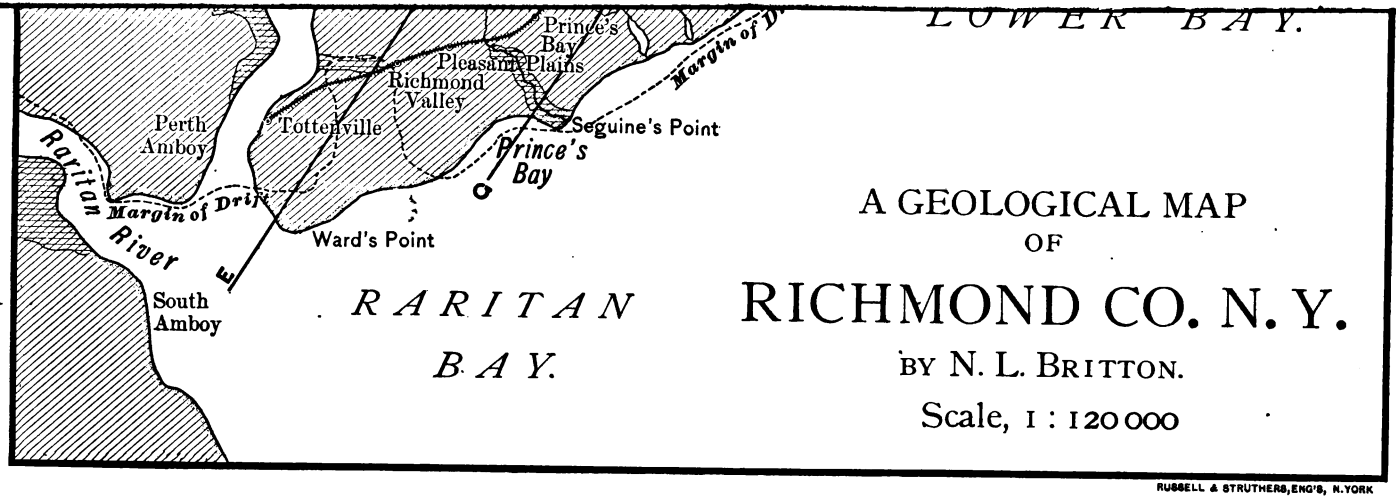

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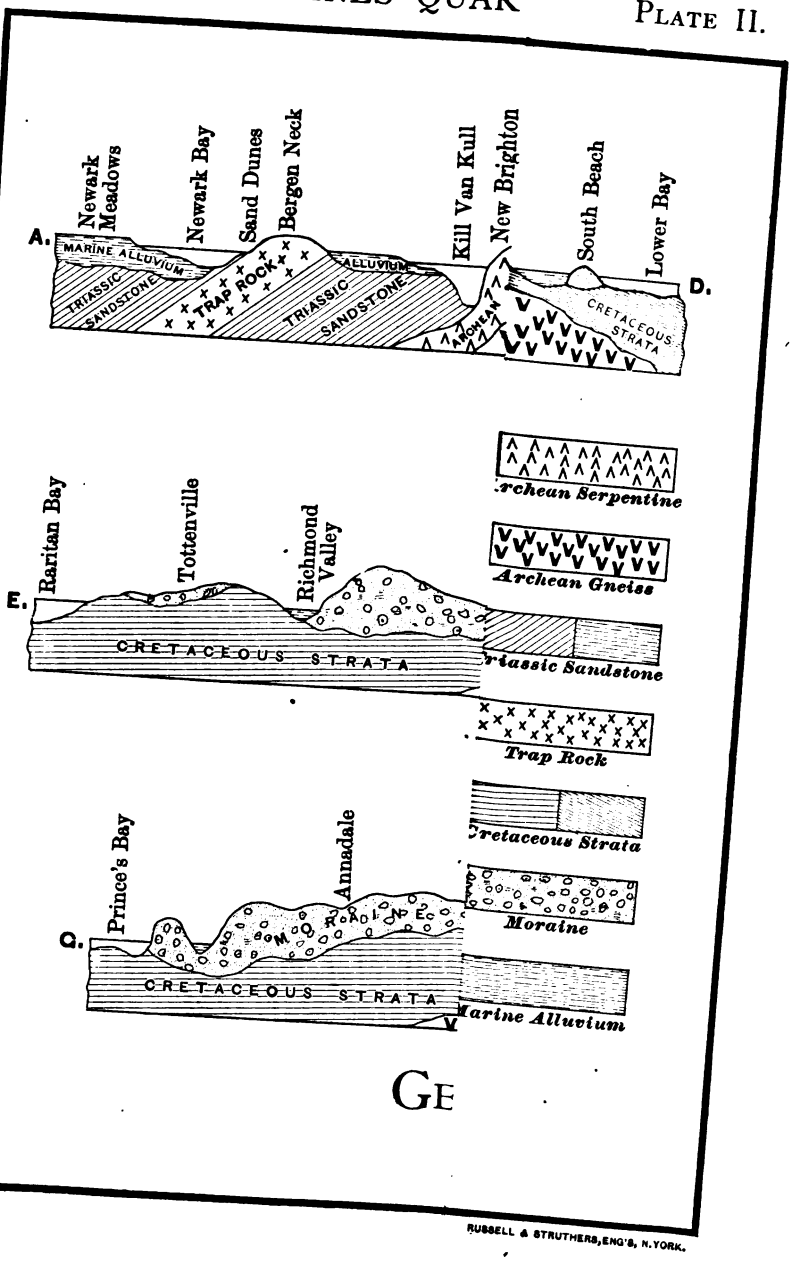

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THE

SCHOOL OF MINES

QUARTERLY.

MAY, 1881.

ON THE GEOLOGY OF RICHMOND COUNTY, N. Y.*

BY N. L. BRITTON, E.M.

RICHMOND COUNTY, consisting of Staten Island, is the most southern portion of the State of New York. In form it is an irregular triangle, whose area is about fifty-nine square miles. Its population, as given by the census of 1880, is 38,994, or 661 to the square mile. Its length is thirteen and one-half miles, and its breadth about seven miles.

Within this territory we have strata of Archæan, Triassic, Cretaceous, Quaternary, and of modern eras; these will be considered in the order of their ages, beginning with the oldest.

ARCHÆAN STRATA.

Granitic Rocks.—True granite occurs on the shore of the Upper New York Bay, about four hundred feet southwest

*Abstracts from a paper read before the New York Academy of Sciences, April 4, 1881.

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of the Tompkinsville steamboat landing. The surface of rock exposed at low tide is about eighty feet wide by fifty feet long; at high water mark the rock disappears beneath a hill of drift some fifteen feet in thickness. There is a little more of the same rock exposed at a point about two hundred feet south of the main outcrop, but everywhere else on Staten Island the granite is covered by newer formations. There is reason to believe, however, that it underlies the magnesian rocks which form the high hills of the island, and extends in a belt of indeterminate width all around the eastern edge of them, covered by the Glacial Drift and Cretaceous strata to an unknown depth; and that the same belt continues in a southwestwardly direction to Arthur Kill, and thence across the State of New Jersey to Trenton, where it again comes to the surface. The approximate position of this belt of metamorphic rocks is indicated on the accompanying map.

Steatitic Rocks.—Magnesian rocks (serpentines), form the tops, at least, of the main series of hills on Staten Island. It is probable that this rock was originally of very considerable thickness, for a large amount must have been removed by erosion, but yet no granite nor gneiss which is assumed to underlie it, has been seen in place within the serpentine area, which is estimated at thirteen and one-half square miles. As to the present thickness it is impossible to obtain an accurate estimate, but judging from the exposures, I should place it at over one hundred feet. The most eastern exposed boundary of the serpentine is clearly and unmistakably marked by a series of sharp slopes which are nearly continuous from Tompkinsville to Richmond, and are in places as straight and regular as they could be constructed.

As to the origin of the serpentines I have no new theory to advance, and consider the one which supposes them to be metamorphosed highly magnesian limestones to be more in accordance with the facts as observed than any other.

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TRIASSIC FORMATION.

Shales and Sandstones.—These rocks are exposed at but two places in Richmond County, and there in but very limited quantities. These are on Shooter's Island at the mouth of Newark Bay, and on the shore near by. Here the strata consist of shaly red micaceous sandstone, differing in no essential particular from that so abundantly exposed in Eastern New Jersey.

Diabase—Trap Rock.—The diabase ridge that disappears beneath the Kill van Kull at Bergen Point, N. J., cuts through the red sandstone of Staten Island from Port Richmond to the Fresh Kill marshes, appearing as a long, low hill, having a general strike of S. 40° W., thus being nearly parallel with the serpentine. Toward its southern end, its elevation is so little more than that of the sandstone, that the position it occupies cannot well be distinguished. The length of this diabase outcrop is about five miles and three-quarters, and its width averages less than one-half mile. Both the eastern and western boundaries of this rock are so obscured by drift, however, that their exact positions cannot be determined, and the outcrop may be wider or narrower at any point than is indicated on the map.

CRETACEOUS FORMATION.

The Cretaceous formation, more or less covered by glacial and modified drift and salt meadows, extends through all parts of the county lying east and southeast of the Archæan rocks. The area underlain by it is, therefore, about twenty-eight and one-half square miles.

The strata consist of beds of variously colored clays and sands, dipping slightly to the southeast, and having a general strike of about S. 45° W. They are a direct continuation of the Plastic Clay division of the Cretaceous of the New Jersey geologists, and lie at the base of the formation in eastern North America.

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The clays are white, yellow, brown, or black; they appear on the surface at a number of places, and the purer varieties have been extensively used in the manufacture of fire-brick, drain-pipe, gas retorts and other refractory ware. The white fire-clay is sometimes associated with the so-called "kaolin." This material, which is very incorrectly named, consists of a mixture of white quartz sand, with small amounts of white mica and clay, and sometimes grains of feldspar. It is known as "kaolin" throughout the clay district of New Jersey, but of course is not a kaolin, as this term is only properly applied to clays formed by the decomposition of feldspathic rocks in place. An analysis of this substance, made in the laboratory of the Geological Survey of New Jersey, is as follows:

SiO_2	92.70 per cent.
Al_2O_3	5.70 "
H_2O	0.70 "
K_2O	0·35 "
	99.45 per cent.

Interstratified with and overlying the clays and sands there are found thin beds of limonite iron ore of limited extent. This substance frequently cements the sand and gravel, thus forming a conglomerate of variable coarseness. Hitherto this iron ore has not often been found in sufficient quantities or of sufficient purity to warrant its use in the manufacture of iron.

QUATERNARY FORMATION.

Glacial Drift.—Deposits of material, brought from the north by the ice of the Glacial Epoch, are found over the greater part of Staten Island, but do not entirely overspread it. The most southern terminal glacial moraine crosses Staten Island from the Narrows to Tottenville, and is distinctly marked by a continuous line of hills. These hills

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mark the most southern extension of the ice-sheet and the line along which the glacier deposited most of its burden of boulders, pebbles, sand and clay, which it had torn from the rocks in its southern journey. The dotted line on the map, extending westwardly from Clifton and ending at Tottenville, represents the most southern and eastern position of the boulder-drift on Staten Island, and has been quite accurately determined. North and west of the morainal hills the drift is not so abundant, rarely forming hills of any considerable size, but boulders are to be found over all this area except where it is covered by newer formations, and the soil is very often clayey.

Modified Drift, or material derived from the glacier, but more or less sorted and stratified by water, may be seen on the plains lying east of the moraine from Gifford's to near Clifton. The soil over this area is seen in well-diggings to be imperfectly stratified, and to consist of loam and sand with few pebbles and fewer boulders.

Limonite Iron Ore.—The era of the formation of these deposits is only provisionally referred to the Quaternary. It is impossible to say how early their formation began, but it was probably long before the Glacial Epoch; we are only sure that they are more modern than the magnesian rocks which they rest upon, and older than the Glacial Drift which overlies them in some places. These beds of iron ore are found resting directly upon the serpentine or talcose rocks at a number of places, and where mining has been carried on, the localities are indicated on the map. All the deposits have the same general characteristics; they are superficial, although sometimes covered by glacial drift to a variable depth. The ore consists of the hydrated sesqui-oxide of iron, limonite, and is either compact or quite earthy in texture. All that I have examined gave a yellowish-brown streak; it is possible that there is some hematite occurring with it, but I have never seen any ore from Staten Island which would give a red streak. The ore is associated with

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colorless red and green quartz. It has been extensively mined near Four Corners; at several places on Todt Hill and Richmond Terrace, and along the Clove Road; it is known to occur at other places on the serpentine hills. The following analyses of the ores have been furnished me by Mr. D. J. Tyson, Jr., of New Dorp.

(1.) *Ore from Todt Hill.*

Fe_2O_3	67.50 per cent.
MgO	1.90 "
CaO	1.46 "
Al_2O_3	5.82 "
P	0.046 "
Mn	0.619 "
SiO_2	10.80 "
H_2O	7.73 "
Cr	3.0) "

The amount of chromium is probably too high.

(2.) *Ore from near Four Corners.*

A.		B.	
Fe_2O_3	79.27 per cent.	Fe_2O_3	76.72 per cent.
Al_2O_3	1.20 "	Al_2O_3	0.96 "
Cr_2O_3	1.15 "	Cr_2O_3	1.60 "
Mn_2O_3	0.32 "	Mn_2O_3	0.64 "
SiO_2	5.70 "	SiO_2	5.52 "
CaO	trace "	CaO	trace "
MgO	trace "	MgO	trace "
H_2O	12.39 "	H_2O	14.76 "
S	trace "	P	trace "
P	trace "		
	100.03		100.20

These deposits have probably had their origin in the deposition of the material composing them from the waters

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of thermal springs, which have come to the surface through crevices in the serpentine; the iron in the solutions was probably in the form of carbonate, which on reaching the surface became oxidized by contact with the atmosphere, and was thrown out of solution and deposited as the hydrated sesquioxide as we now find it. Magnetic iron sand occurs with the limonite in one of the deposits on Todt Hill; this was probably washed in mechanically, while the hydrated oxide was being deposited from solution. The deposits vary from a few inches to twelve feet, or even more in thickness; their lateral extent is limited to a few hundreds of feet in any direction. The Todt Hill mines are the only ones wholly uncovered by glacial drift, being east of the moraine.

MODERN EPOCH.

Marine Alluvium or Salt Meadows.—These deposits extend over an area of about nine and one-half square miles on Staten Island. The material composing them consists for the most part of partially decomposed vegetable matter, mixed with a little clay and sand. These salt meadow areas have formerly been shallow bays, which have gradually been filled up by the deposit of silt from their waters, and the growth of marine plants in the first place, and ultimately by the growth and decay of grasses and rushes. This latter process is yet in operation, and keeps the salt meadows at about the level of the highest tides.

Sand Beaches and Points.—Sand beaches occur along all the shores that are directly exposed to the waves; the greatest accumulation of sand is on the shore of the Lower Bay, from Clifton southward, to the so-called Point of the Beach near Gifford's, at Seguine's Point, near Prince's Bay, and at Ward's Point, Tottenville.

Sands composed of magnetic iron ore occur with the quartz sand, and are generally found in layers of a fraction of an inch in thickness; but an accumulation of this sub-

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stance to a depth of four inches has recently been found at low water on the beach near the Elm Tree Lighthouse, and has excited some attention as a possible iron ore; but it contains titanium, and is not likely to have any economic importance.

Peat Swamps.—True peat occurs in but few places on Staten Island. Some may be found in the Clove Lake Swamps, in several swamps near Gifford's and Richmond, and toward Tottenville. The salt marsh deposits may be regarded as a kind of peat, but their vegetable matter comes from grasses and rushes, while true peat results from the growth and decomposition of mosses.

ECONOMIC GEOLOGY.

Iron Ore.—The limonite of Todt Hill, Four Corners, and other places, has been used in blast-furnaces, in connection with other more refractory ores, or has been made into red ochre paint. The total amount hitherto mined may be as great as two hundred and fifty thousand tons, and the present production is about twenty thousand tons per annum.

Fire Clay.—The character of these deposits has already been described. Messrs. Kreischer & Sons have a large factory at Kreischerville, and produce refractory ware valued at over $50,000 annually. Their supply of clay is partly drawn from Woodbridge, N. J.

Brick Clay.—Clays of glacial drift origin are used in the manufacture of common brick near Richmond and Linoleumville. The number of bricks annually produced has not been definitely ascertained, but it probably amounts to several millions.

Trap Rock.—Quarries of this rock have been worked at Graniteville and near Port Richmond for many years. The stone is either cut into blocks, shipped to New York and used for street pavements, or crushed into small pieces and employed in Macadam or Telford road pavements on

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Staten Island. Some edifices have been constructed of this rock, but it is not well suited for building purposes.

Serpentine Rock.—The compact variety has not yet been used for any economic purpose; it is too soft and weak to be used in building. It might be employed in the manufacture of magnesian salts, or for some purposes where refractory materials are required.

The fibrous serpentine, erroneously called asbestos, has been mined near Tompkinsville Landing to the extent of twenty-five or thirty tons, and used for the purposes for which asbestos is employed.

Beach Sand.—Thousands of tons of sand are annually taken from the southeastern coast, and used in New York and Brooklyn for building purposes.

IRON ASSAY NOTES.

BY T. B. STEARNS.

In assaying an iron ore of a given composition, lime (CaO), silica (SiO_2), and Alumina (Al_2O_3), one, two, or all three, are added in proportions such as to flux the gangue of the ore, and give a slag of the composition:

CaO....3 parts,
SiO_2....$2\frac{1}{2}$ "
Al_2O_3...1 "
} known as Percy's slag.

Owing to the fact that the Al_2O_3, if added, must be added in the form of kaolin ($\frac{1}{2}$ Al_2O_3; $\frac{1}{2}$ SiO_2), an error is committed in the method of calculation in the text-books. This error consists in calculating, in certain cases, an amount of flux to be added greater than is necessary to just flux the gangue, thereby causing a waste of material. The amount of material thus wasted is, of course, insignificant in the assay, but when we wish to apply the results of the assay

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directly to practice, as in calculating on the assay as a basis, the amount of flux required for the same ore in charges proportioned to an eighty-ton blast-furnace, the waste of flux becomes enormous.

Cases may arise where kaolin, silica or lime, any one or any two of which, must be added to produce the required slag. The example is very simply solved when only lime and silica must be added. The deficiency is found by subtracting the amount in the gangue from the amount required, and the amount of deficiency is added directly.

Not so, where kaolin has to be added, for here, for every part of kaolin, we put in alumina and silica half and half. To add the requisite amount of kaolin to *just* flux the excess of lime and silica, one or both, the following method may be used. According to Percy : $SiO_2 : CaO : Al_2O_3 : : 2\frac{1}{2} : 3 : 1$ or $: : 1 : \frac{6}{5} : \frac{2}{5}$.

Suppose we add the amount of Al_2O_3 necessary to flux the silica.

Then we have—

Parts.

SiO_2 ... 1.
Al_2O_3... $\frac{2}{5}$.
CaO ... $\frac{6}{5}$.

But, to add $\frac{2}{5}$ Al_2O_3, we are obliged to add $\frac{2}{5}$ SiO_2, and to flux this, more Al_2O_3 is necessary; so, by successive additions, we get—

SiO_2 $1+\frac{2}{5}+(\frac{2}{5})^2+(\frac{2}{5})^3$..... $(\frac{2}{5})^n$;
Al_2O_3 $\frac{2}{5}+\frac{2}{5}$ of $\frac{2}{5}+(\frac{2}{5})$ of $(\frac{2}{5})^2+(\frac{2}{5})^4$..... $(^2)$ $(\frac{2}{5})^n$;
CaO $\frac{6}{5}+\frac{6}{5}$ of $\frac{2}{5}+\frac{6}{5}$ of $(\frac{2}{5})^2+(\frac{6}{5})$ $(\frac{2}{5})^3$.... $(\frac{6}{5})$ $(\frac{2}{5})^n$;

or, it may be written—

SiO_2 1 $(1+(\frac{2}{5})+(\frac{2}{5})^2+(\frac{2}{5})^3+$..... $(\frac{2}{5})^n)$;
Al_2O_3 $\frac{2}{5}$ $(1+(\frac{2}{5})+(\frac{2}{5})^2+(\frac{2}{5})^3+$..... $(\frac{2}{5})^n)$;
CaO $\frac{6}{5}$ $(1+(\frac{2}{5})+(\frac{2}{5})^2+(\frac{2}{5})^3+$..... $(\frac{2}{5})^n)$.

But the series $1+\frac{2}{5}+(\frac{2}{5})^2+$...., $(\frac{2}{5})^n$ is equal to $\frac{1}{1-\frac{2}{5}}=\frac{5}{3}$. (See Algebra, Series.)

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Replacing the series by its value ($\frac{5}{3}$), we get:

$$\left.\begin{array}{l} SiO_2\ 1\ (\frac{5}{3}) = \frac{5}{3} = \left\{\begin{array}{l} \frac{3}{3} = SiO_2 \text{ in ore;} \\ \frac{2}{3} = \text{“ “ kaolin;} \end{array}\right. \\ Al_2O_3\ \frac{2}{5}\ (\frac{5}{3}) = \frac{2}{3}; \\ CaO\ \frac{6}{5}\ (\frac{5}{3}) = \frac{6}{3}, \end{array}\right\} (1)$$

preserving the proportion $2\frac{1}{2} : 1 : 3$.

To show the application of this method, a few examples are appended.

Ores analyzing as follows:

	1.	2.	3.
Al_2O_3	2 per cent.	0 per cent.	0 per cent.
CaO	3 “	0 “	9 “
SiO_2	15 “	10 “	2 “

are required to be assayed.

(1). 2 pts. Al_2O_3 require 6 pts. CaO and 5 pts. SiO_2 to make Percy's slag, leaving to be fluxed 10 pts. of SiO_2; how much Al_2O_3 and CaO shall we add?—By the proportion (1) $\frac{5}{3} : \frac{2}{3} : \frac{6}{3}$.

$\frac{5}{3} = \frac{3}{3}$ SiO_2 present as SiO_2, and $\frac{2}{3}$ added in the kaolin.

$10 = \frac{3}{3}$ of $10 = SiO_2$ in ore.
$\frac{40}{3} = \frac{4}{3}$ “ = kaolin added.
$\frac{60}{3} = \frac{6}{3}$ “ = CaO “

We now have:

15 parts SiO_2,
3 “ CaO,
2 “ Al_2O_3,
} already in the ore, and

$\frac{20}{3}$ parts SiO_2 added in the kaolin,
$\frac{20}{3}$ “ Al_2O_3 “ “ “
$\frac{60}{3} + 3$ parts CaO added as CaO,

making a total of—

$\frac{65}{3}$ parts SiO_2,
$\frac{78}{3}$ “ CaO,
$\frac{26}{3}$ “ Al_2O_3,

in the correct proportion for Percy's slag (*i. e.*, 65 : 78 : 26, or as $2\frac{1}{2} : 3 : 1$), and with no waste of material.

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(2). By analysis :

Al_2O_3..... 0 ;
CaO..... 0 ;
SiO_2..... 10 per cent.

10 parts SiO_2 in the ore $= \frac{8}{3}$ of 10 ;
$\frac{40}{3}$ " kaolin added $= \frac{4}{3}$ of 10 ;
$\frac{60}{3}$ " CaO " $= \frac{6}{3}$ of 10 ;

and since kaolin $= \frac{1}{2}$ SiO_2 ; $\frac{1}{2}$ Al_2O_3, we have $10+\frac{20}{3}$ of SiO_2, $\frac{25}{3}$ parts Al_2O_3, $\frac{60}{3}$ parts CaO, still preserving the relation :

$\frac{50}{3} : \frac{20}{3} : \frac{60}{3}$, or
$2\frac{1}{2} : 1 : 3$

(3). By analysis :

Al_2O_3.....0 per cent.
CaO .....9 "
SiO_2 .....2 "

$2 = \frac{3}{3}$ of $2 = SiO_2$ in ore.
$\frac{12}{3} = \frac{6}{3}$ of $2 =$ CaO to be added.
$\frac{8}{3} = \frac{4}{3}$ of $2 =$ kaolin to be added.
} to flux this SiO_2.

But there is an excess of CaO.

So, by a proportion,

$$4 : 9 : 2 : x = \tfrac{18}{4} = \tfrac{9}{2},$$

By subtracting 2 from $\frac{9}{2}$, we get the SiO_2 to add, and by a proportion,

$$4 : 9 :: \tfrac{8}{3} : x = 6$$

we get the kaolin to add. So we have

0 parts Al_2O_3 / 9 " CaO / 2 " SiO_2 } in ore, and 3 parts Al_2O_3 / 0 " CaO / $1\frac{1}{2}$ " SiO_2 } added,

making a total of

3 Al_2O_3, 9 CaO, $\frac{15}{3}$ SiO_2, or as
1 : 3 : $2\frac{1}{2}$.

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ACTION OF CONCENTRATED SULPHURIC ACID, AT 100° C., ON LEAD AND ITS ALLOYS.

BY L. PITKIN.

THE only work of any importance done, in the estimation of the effect produced upon lead by hot concentrated sulphuric acid, is that of Bauer. The acid used by him was 170° T. (Sp. Gr. 1.848), the amount of lead or alloy taken 0.2 gramme, and the amount of acid used 50 c.c. A brief abstract of his work, so far as it relates to alloys used by me, is here given.

I. *Pure lead.*—The first sensible evolution of gas was at 175° C., a stronger action taking place at 190° C., while at 230°—240° C. all of the lead was suddenly changed to sulphate.

II. *Lead and bismuth alloys.*—

(*a*). Pb. 90 per cent., Bi. 10 per cent.

Action begins at 150° C., continues quietly to 190° C., when all of the metal is decomposed.

(*b*). Pb. 96 per cent., Bi. 4 per cent.

This alloy decomposes more quickly than (*a*), the action terminating at 130°—140° C.

(*c*). Pb. 99.27 per cent., Bi. 0.73 per cent.

Rapid and sudden decomposition at 160° C.

III. *Lead and antimony alloys.*—

(*a*). Pb. 90 per cent., Sb. 10 per cent.

A slow and even decomposition takes place, beginning at 190° C., terminating at 240° C.

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(*b*). Pb. 95 per cent., Sb. 5 per cent.

Decomposition begins at 180° C., terminating at 225° C.

(*c*). Pb. 99 per cent. Sb. 1 per cent.

Action begins at 250°, ends at 280° C.

IV. *Lead and tin alloys.*—Sudden decomposition at 200° C.

The alloys used by me in determining the effect of hot acid were the same as those employed in estimating the action of cold acid, namely, lead with antimony, tin, bismuth, cadmium, silver, and zinc. The amount of acid was as before, 10 c.c. and the surface exposed 2 sq. in., but the time of exposure was 1 hour, instead of 24 hours, as in testing with cold acid. The amount of gas given off per square foot was not calculated, as that factor would be essential only in the employment of lead for cases. The amount of lead or alloy converted into sulphate per square foot is given in grammes.

The four samples of pure lead, exposed to the action of concentrated acid at 100° C. for one hour, gave very concordant results, as follows:

41.	Pure lead.....	1.368	Grammes.
42.	"	1.152	"
43.	"	1.224	"
44.	"	1.080	"

The effect of antimony in composition with lead is shown in the following experiments:

45.	Pb. 100 parts,	Sb.	½	part....	2.952 G.
46.	"	"	1	"	3.672 G.
47.	"	"	2	"	3.528 G.
48.	"	"	3	"	3.096 G.
49.	"	"	5	"	2.736 G.
50.	"	"	10	"	2.952 G.

Upon immersing the alloy, very little gas was given off, and for 40 minutes the acid remained clear. It then commenced to cloud, and the alloy taken out at the end of the

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hour was covered with black slime. It will be seen that at 100° C. the action of antimony is not that of a preservative of the lead, as is the case with cold acid; while from the experiments of Bauer, quoted above, it seems quite likely that at elevated temperatures the alloy with antimony may be more resisting than pure lead. The relative solubilities of the alloys at ordinary temperatures and at 100° C. are by no means constant, and this forms one of the most interesting features of the investigation; thus, if at common temperatures the alloys with antimony, are found more insoluble than those with zinc, we cannot predicate the same relation with acid at 100° C. In regard to the action of tin upon lead, as affecting its solubility, the following results were obtained:

51.	Pb. 100 parts,	Sn.	½	part....	1.008 G.
52.	"	"	1	"	0.792 G.
53.	"	"	2	"	0.864 G.
54.	"	"	3	"	0.792 G.
55.	"	"	5	"	0.864 G.
56.	"	"	10	"	0.864 G.

It will be remembered that one of the general results obtained from the experiments with cold acid was, that at ordinary temperatures the alloys of lead and tin were more easily attacked than those with antimony, or pure lead itself, and yet at this temperature we see the case reversed.

It is, however, in regard to bismuth that the most curious effects were found to be produced by the composition of the alloy. The following figures will fully explain the peculiar action of the bismuth:

57.	Pb. 100 parts,	Bi.	½	part.....	24.840 G.
58.	"	"	1	"	22.248 G.
59.	"	"	2	"	1.800 G.
60.	"	"	3	"	1.008 G.
61.	"	"	5	"	1.008 G.
62.	"	"	10	"	2.160 G.

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The results given in 57 and 58 appear so exceptional, not only in comparison with other alloys, but in regard to the sudden change shown in 59 and 60, that it was decided to make Experiments 57, 58 and 60 in duplicate.

57.	(Duplicate) Pb.	100 parts,	Bi. ½..	25.920
58.	"	"	Bi. 1..	22.750
60.	"	"	Bi. 3..	1.224

We here have a case in which not only the relative solubility in hot and cold acid is changed as regards other alloys, but one in which an excess of the deleterious substance seems to act as a corrective.

The alloys containing ½ and 1 part of bismuth to 100 of lead gave off gas very plentifully, not only at the start, but throughout the whole hour, while the acid became opaque almost immediately, and the lead sulphate formed could be removed in scales at the end of the experiment.

The experiments with cadmium alloy gave very constant results, and in general it may be said that, with the exception of bismuth alloy, the figures obtained from the same alloy varied much less than in the corresponding trials with cold acid.

63.	Pb. 100 parts,	Cd.	½	part.....	1.440 G.
64.	" "	"	1	"	1.224 G.
65.	" "	"	2	"	1.296 G.
66.	" "	"	3	"	1.080 G.
67.	" "	"	5	"	1.368 G.
68.	" "	"	10	"	1.152 G.

The action of cadmium at this temperature seems to be neither increasing or diminishing the action of the H_2SO_4 on the lead.

In the case of silver combined with the lead, we have the same general behavior, six determinations with varying quantities of silver giving the following results:

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69.	Pb. 100 parts,	Ag.	½ part	....	1.296 G.
70.	"	"	1 "	....	1.080 G.
71.	"	"	2 "	....	0.864 G.
72.	"	"	3 "	....	0.792 G.
73.	"	"	5 "	....	0.936 G.
74.	"	"	10 "	....	1.440 G.

The action of zinc in determining the solubility of lead in hot acid is in accordance with its effect on cold concentrated acid—that is, increases the effect of the acid, but the action is not so marked as at ordinary temperatures. The figures for the experiments are:

75.	Pb. 100 parts,	Zn.	½ part	.....	1.800 G.
76.	"	"	1 "	.....	1.296 G.
77.	"	"	2 "	.....	1.152 G.
78.	"	"	3 "	.....	1.080 G.
79.	"	"	5 "	.....	1.296 G.
80.	"	"	10 "	.....	1.080 G.

We can easily see from the results we have obtained the importance of testing the lead employed in H_2SO_4 working, and for this no extended analysis is required. The operation consists simply in immersing the lead in acid, more or less concentrated according to the strength of the acid with which it will be brought into contact in actual working, and at the temperature to which it will be subjected in the manufacture of acid.

Mr. McTear says: "The simplest safeguard against risk to pans, etc., giving way would be a careful testing of the lead previous to being made into sheets. For this purpose it will not be necessary to make an analysis, but simply to put clean, thin shavings of lead into a test-tube and cover with pure, cold vitriol, the amount of action would then be clearly visible."

It is, however, clear that the action of cold acid is no sure criterion of the effect that hot acid will have upon the lead;

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so, to avoid error, it is much safer to test the lead under the conditions of its actual employment.

In order to briefly sum up the results of experiment, it will be advantageous to compare the average of the alloys with pure lead as unity both at ordinary temperatures and at 100° C. The following table will therefore express the average solubility or liability to formation of sulphate of the alloys in terms of lead. In each case the total of the relative solubilities is divided by six (the number of members in the class), for the average solubility of the alloys:

	20° C.	100° C.
Pure lead	1.00	1.00
Pb. 100, Sb. 1–10 parts	0.81	2.75
Pb. 100, Sn. 1–10 "	1.42	0.75
Pb. 100, Bi. 1–10 "	1.10	7.69
Pb. 100, Cd. 1–10 "	0.86	1.10
Pb. 100, Ag. 1–10 "	0.87	0.93
Pb. 100, Zn. 1–10 "	1.53	1.10

STEAM ON THE CANALS.

BY CHANDLER D. STARR.

PART II.

WE now turn to consider those methods of applying steam to canal navigation, in which the water is the resisting medium for the propelling force. Although acting under a most serious disadvantage from the yielding nature of the fulcrum, some of the plans have achieved considerable success by reason of their simplicity and the directness with which the power is applied. The loss of power due to the slip of ordinary paddle-wheels and screw-propellers is well known, and has given rise to many devices for

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obviating it. It has been proposed to propel vessels by ejecting water from the stern, by a system of oars worked by an engine, by a reciprocating rod provided with feathering floats or paddles, by a sort of shutter swinging at the stern, and by many similar devices of equal inefficiency. Ordinary paddle-wheels have been tried at the bow, the stern, and the sides, but have generally given place to the screw, as in open-water navigation. Where the water is one and a half feet deeper than the boat, it is found that the screw is superior. In less depth the paddle-wheel gives the better result, although still objectionable where locks are to be passed, on account of the space consumed.

The early development of steamboats took place chiefly in connection with canals, and a history of the first application of steam to canal navigation would, therefore, be little else than a repetition of the growth of the ordinary steam-vessel. Steam propulsion became an established fact for ships; but, notwithstanding many attempts to apply it to barge canals, little or nothing was accomplished up to the year 1871, when the State of New York took the matter in hand. The growing power of the New York Central Railroad was fast monopolizing the grain trade between Buffalo and New York City, and, unless steps were taken to divert the tendency of freight to follow the land lines, the Erie Canal might soon be closed. It was evident that in the application of steam lay the remedy, and to excite inventors to their best efforts, the Legislature offered a prize of $100,000 for any invention which would profitably and practically accomplish this result. The conditions demanded of competing boats were as follows:

The boat shall, in addition to the weight of the machinery and fuel, transport at least two hundred tons of cargo. The rate of speed shall not average less than three miles an hour, without injury to the canals or their structures. The boat must be capable of being easily stopped or backed by the power of its own machinery. The simplicity, economy

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and durability of the device must be elements of its worth and usefulness. The invention must be such that it can readily be adapted to the present canal-boats and will lessen the cost of canal transportation, and increase the capacity of the canals. Nor must it interfere in any manner with the present method of towage. From this competition were excluded the Belgian or Cable system, and any mode of propulsion by steam-engine or otherwise, upon either bank of the canal. As was expected, the attention of inventors and others was immediately turned to the accomplishment of the desired result, but a general misunderstanding as to the points of difficulty was found to exist. The idea prevailed that prevention of injury to the banks of the canal from the wash of the steamer was the first thing to be effected, and the commissioners therefore announced that "the experiments heretofore made in navigating the canals by freight-boats propelled by steam had not been failures by reason of injury done the banks of the canals, by the swells caused either by the motion of the boat or the wheels through the water. The main difficulty to be overcome is to establish the economy of steam or other motor as compared with animal power." In the meantime several plans had been devised to prevent this wash; among them was a double-hulled steamer with a paddle-wheel between, and with bows shaped with a curve only on the inside, the outside of each being perfectly straight. Of course such a vessel as this could not carry anything like the amount of cargo conveyed in a "bull-head" all but filling the locks; or, dropping from consideration the locks, the shape of the boat forbids a profitable use of fuel in obtaining the necessary speed. Another proposal was a false bow, which, by means of hinges at the deck, could be raised when a lock was to be passed. Still another was a small tug, so shaped that it could be firmly attached to the blunt bow of a barge and thereby give the latter somewhat the benefits of a clipper shape. In all, seventeen boats appeared on the

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canal, most of them only to demonstrate their uselessness. Theoretically and on paper, one of the most plausible devices was the Goodwin boat, a flat-bottomed barge, with the bow cut away in cylindrical shape. The propelling instrument was placed ahead and was a hollow, water-tight drum, with blades on its outer surface. These blades made an angle with the elements of the cylinder, each forming an obtuse angle in itself at the middle. The outer ends would therefore come in contact with the water first, and the immersion of the blade take place gradually and without shock. This construction inclined the water moved by the paddles toward the centre, and aided the wings, which extended forward from each side of the bow, in sending the water under the boat. It was further claimed for the paddles that they rose from the water without lifting it as the straight paddle does, the angle at which they were set giving the water time to escape. A steamer of this pattern, with a twenty horse-power engine, was built for the Erie Canal. Its special recommendation was being adapted to overcome the extraordinary resistance to high speeds which exists in confined channels. In an indefinite expanse of water the power required to propel a vessel increases as the cube of the velocity. As a boat moves forward the water which it displaces takes up a movement toward the rear to fill the space previously occupied. If any obstacle is presented to this motion greater than the surrounding water, the ratio of resistance will increase. In a narrow canal the banks and bed offer this obstacle. It has been determined that when the area of the cross-section of the canal is six and one-half times the immersed section of the boat, and its width four and one half times that of the boat, the relations are as in the open sea. Both the area and width of the cross-section of the Erie Canal are less than those multiples of the corresponding dimensions of the large boats, and it may be deduced from the formula of D'Aubuisson that forty-four per cent. more power

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is required for the same speed on the Erie Canal than in an indefinite expanse. The lines and curves of swift-going vessels are so constructed as to facilitate to the utmost the passage of the water from bow to stern; but the demand for carrying capacity on the canal, and the limiting dimensions of the locks, forbid similar modelling, and produce the familiar bluff-bowed barge. In all cases of moving vessels there is a continual tendency to heap up the water ahead of the bow and to leave a hollow underneath the stern. The reason for this is self-evident, and the result is an inclined plane up which the craft is perpetually climbing, with its bow higher than its stern. Sharp lines and absence of confinement go far to obviate this difficulty; the conditions of canal navigation exaggerate it. The effect increases as the channel narrows; so that, if the latter be no wider than the boat, the water will be heaped up high in front; it it be only deep enough to float the vessel while motionless, the stern will ground as it moves ahead. These conditions require, for obtaining high speed, an increase of power altogether disproportionate to the gain, besides producing a swell which presently injures the banks. Whereas three horses can tow a boat carrying two hundred and ten tons at the rate of two miles an hour on the Erie Canal, twenty-three horses would be required to increase the speed of that same boat to four miles an hour.

The "Goodwin Bow Propeller" proposed to aid the displacement of the water by its action, and to create an inclined plane which should be highest at the stern, that gravity might act with, instead of against, the progress of the boat. The inventor had been a navigator of stern-wheel steamers on the Ohio River, and had there formed the idea which was incorporated in his boat. He found that when his vessel grounded in attempting to cross bars, he was frequently enabled to pass by turning the boat and running stern foremost. He ascertained also, that in narrow

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channels better time could be made with the wheel ahead. Actual experiments were made, in which the vessel was placed in a confined water-way and successively propelled by a tow-line, by power applied at the stern, and by the wheel at the bow. With the first two the water was heaped up in front, overflowing the banks, and the boat only moved fast enough to create the overflow. With the last the boat made rapid progress, the water surging up at the stern, but making no side swells. Then the boat was loaded down at the stern until it grounded; on the propeller being set in motion the stern rose and the boat moved on. Finally she was grounded from bow to stern, and even then, by the effect of the propeller, was able to make some progress.

In the face of these seductive facts the boats were unsuccessful, and to-day are almost forgotten. Why they failed to meet the expectations formed, and what were those other facts about them which existed, but had been disregarded, we can only suggest for ourselves. Enterprises are like men, in that when dying untimely deaths only their merits are remembered, and the records fail to give their faults. Without doubt the direct and immediate cause of failure was the inability to transport freight cheaper than the horse-boats, and the explanation of this is to be found in an excessive consumption of fuel due to indirect and inefficient application of the power. A propelling instrument, whether on the paddle or screw principle, necessarily throws a current of water backward. In this consists what is called the "slip." If the propeller be ahead of the boat, this current will act to retard the latter just as would an adverse flow of the stream, and the advantages displayed in very narrow channels—as in Goodwin's experiments—would be, in the case of a freight-boat on the canal, at an expense of fuel incommensurate with the gain.

No boat met the requirements of the act establishing the prize, and the latter was therefore not awarded. Three, however, did so well that the commissioners recommended

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awards of a smaller amount, and these were accordingly made by the Legislature as follows:

Steamer	"Wm. Baxter," W. Baxter, Prop.,	$35,000
"	"Wm. Newman," D. P. Dobbins, Prop.,	$15,000
"	"Central City," Theo. Davis, Prop.,	$5,000

Conditions were imposed that, during the season of 1874, Baxter should place on the canal seven boats of the power and capacity of the "City of New York," which was a slight improvement on the "Baxter," completed too late for the contest; that Dobbins should furnish three boats similar to the "Newman," and that Davis should run the "Central City." The "City of New York" was thus distinguished as being the best steam canal-barge built up to the year 1873, and as such we may consider it the outgrowth of the many failures going before. We may also take it as a guide to future experiment, pointing out the best path for our endeavors. The notable point in its construction is the absence of any startling novelty, its excellence depending on the improvement of common means. A full description of these details is deserving of space.

The hull is of the largest size permitted by the locks, 96 feet long, 17 feet wide, and drawing 6 feet. The bottom is perfectly flat, and the sides, stem and stern are vertical; she has consequently a uniform horizontal section from her bottom up to 5.5 feet draught. Above this the sides are carried out backward, forming an overhang at the stern to give deck-room and for the protection of a single screw having four blades and a moderate pitch. The form and dimensions of the hull are the same at the bow and stern, so that if a line be drawn athwart the plan at right angles to the keel, and midway between the stem and sternpost, such a line would be one of symmetry. The sides converge from points distant 20 feet from both ends on curves of thirty feet radii. When carrying 200 tons she draws 5 feet 8.5 inches. The cabin is placed forward and

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the engine-room aft. The machinery is of the compound type, and is characteristic for its simplicity, compactness, and smoothness of operation. The space occupied by the engine is about two and a half feet square on the floor, by about seven feet high. The cylinders are three in number, all in a single casting; two are high pressure, 4.75 inches diameter, and the third low pressure, 14 inches diameter. The common stroke of piston is 14 inches. Although there are three cylinders, the steam is admitted and exhausted through a single valve operated by a single valve-gear. The condenser is cheap and simple and moderately efficient, and consists of an extension of the exhaust from the low-pressure cylinder through the side of the boat, where it connects with a three-inch iron pipe which passes around the stern and enters upon the opposite side. At this point is a small air-pump operated by a crank attached to the shaft. The condensation is effected by the action of the water in the canal upon the exterior surface of the pipe outside the boat. The vacuum obtained by this means varies from 12 to 22 inches, depending upon the temperature of the water and the quantity of steam in use. The water of condensation is returned directly to the boiler, and the necessity of supply from the muddy water of the canal obviated. The reversing lever, throttle-valve, and steam-whistle are all within easy reach of the steersman, and the steam and vacuum gauges are so disposed as to be visible from the wheel. A single man can therefore perform the duties of steersman and engineer, and the fireman be left free to give his whole attention to the fire and to keeping the engines properly oiled. The boiler is vertical, cylindrical, tubular, 48.75 inches diameter, about 7 feet high, and provided with a simple and efficient superheater. The fire-box is 3 feet 10 inches diameter and 2 feet high. The tubes are 2 inches diameter, 4 feet long, and 162 in number. The grate surface is something over 9 square feet, and the heating surface about 360 square feet. A small fan-blower is

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provided for supplementing the natural draft whenever desirable.

The "Wm. Baxter" was of similar construction, except in having a smaller boiler and two screws, each three-bladed, 4 feet pitch and 4.5 feet diameter. The propelling instrument of the "Newman" was a single screw. The "Central City" was equipped with two adjustable paddle-wheels, 9 feet 10 inches in diameter, the buckets of which were set at an angle with the elements of the cylinder and forced the water toward the middle of the canal. The engine had a single cylinder, 10 inches diameter and 17 inches stroke. The engine-house (with boiler, engine, and machinery), could be elevated by four screws to nearly the height of the deck when the boat was loaded; the cabin for the crew was raised in the same manner, leaving the entire hull available for cargo, and thus making up for the space consumed by the paddle-wheels.

The final trial of these boats took place, October 15, 1873, between Syracuse and Utica, a distance of fifty-six miles, each boat carrying 200 tons, with the results indicated in the following table:

	Total Time.	Miles per Hour.	Lbs. of Coal per Mile.	Efficiency of Propeller.
	H. M.			
Baxter	20 09	3.09	14.8	.679
Newman	27 08	2.59	71.5	.337
Central City	27 52	2.53	126.4	.460

This table suggests some interesting conclusions, although in its consideration certain allowances must be made for the extra effort put forth under the circumstances. The record of the "Baxter" shows that, while making one-fifth more speed than the "Newman," its coal-consumption was only one-fifth as great. This is a surprising exhibit, and shows how completely the great problem is one of improvement rather than of invention. The "Baxter" had two screws,

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and the "Newman" only one; but the performances of the "City of New York," with one screw, subsequently equalled those of the "Baxter." It will be observed that none of the boats averaged three miles an hour when detentions are included, although, that this should be done, was one of the conditions of the prize. No doubt any of them might have accomplished it with a sufficient supply of fuel; but that other condition, providing for transportation cheaper than by animal power, demanded equal attention. Extensive calculations were made on the results of this and longer trips, and it was shown to the satisfaction of engineers and capitalists that such boats as the "Baxter," could be run with profit. Accordingly, the "Baxter Steam Canal-Boat Transportation Company" was organized, and, having secured Dobbins' claim on the State award, they placed on the canal the ten boats necessary to obtain the amounts due him and Baxter. The boats did well, the owners profited, and the following year five steamers were added to their fleet. Then came financial troubles in connection with the stock, and the company met its end, although the success of the boats was firmly established. The vessels became the property of individuals, and, as such, are yet on the Erie Canal. Other steamers have also been built for the route, and an improved method of running them has been the means of still further reducing the cost of transportation. It is found that an economy of power results from coupling boats close together, in pairs, one ahead of the other. The method is the suggestion of Mr. William Frick, and goes by the name of the consort system. The total resistance, when moving at a speed of 2.5 miles, is said to be 30 per cent. less than for two single boats, whatever the means of propulsion, and the crew required is no greater than for one boat. Coupled boats are in use on the Pennsylvania, the Susquehanna, and the Erie Canals. They are in some instances towed by animals, and in others the rear boat of the pair is a steamer; in this latter case a sec-

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ond pair of boats may be attached by a tow-line to the one carrying the power. Mr. Frick claims that his device makes the system of towing by locomotives not only a possibility, but the best of all systems—the difficulties arising from the flexible nature of the train, as discussed in the last paper, being so far overcome as to establish the practicability of towing six boats at a time. This seems unlikely; but, even if quite true, there still remains the disadvantages of power applied at an angle, and excessive delay at locks. There is no doubt, however, of the benefit to be derived from coupling boats where the screw propeller is the source of motion. The following statement shows the comparative achievements of the various systems on the Erie Canal in 1874:

System.	Trips in the Season.	Buffalo to New York. Cost per Ton.	Per Ton per Mile.	Buffalo to New York. Cost per Bushel Wheat.
Animal	7	$1.896	$0.0038	$.0569
Cable	8	1.74	0.0035	.0522
Baxter	10	1.92	0.0039	.0576
Consort	9	1.57	0.0032	.0472

These figures change from year to year, and their absolute values go for nothing, but their relative values remain practically the same, and we may with safety draw conclusions from them. The estimates relating to the cable system are made on the supposition that the whole canal is equipped with cables and tugs, and all of its business done in that way. The cost for transporting a bushel of wheat from Buffalo to New York by a Baxter steamer alone is .7 of a mill greater than by animal power; that is, when the profit of a horse-boat is 1.32 cents on the bushel, as it was that year, the "Baxter" would only gain 1.25 cents; but the "Baxter" carries ten bushels to seven of the other in the course of the season, by reason of making its trips in shorter time, and this would increase the total gain to more than that of the latter. The number of trips set down for the steamer and consort

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is one greater than they are usually able to make; but, considering the number of trips to be eight instead of nine, it still remains by far the most economical of the list. That this is practically realized by the owners of steam canal-boats is shown by the fact that in 1878, out of nineteen steamers plying between Buffalo and New York, twelve were coupled to a consort and two were run with a pair of coupled boats in tow. In this latter arrangement the tow-rope was about 225 feet long. Besides these steam-boats, there were six boats coupled and steered by Frick's plan, and towed by horses. The single steamers can go from Lake Erie to the coast in about seven days and return in the same time, while double boats require from nine to ten days for the trip. The steam canal-boat towing two coupled barges requires from twenty-five to thirty days for the round trip, which is about the same as the single-horse boats.

Considering the problem in its entirety, one is at a loss in deciding as to its satisfactory solution. There are the two Belgian canals on which are operated a line of cable-towing in the one instance, and of locomotive-towing in the other. In opposition to this are the American canals, on which, notwithstanding strenuous efforts directed toward the application of steam, animal power is still in an overwhelming ascendant. To reconcile these two aspects of the question we must bear in mind that the introduction on the Belgian canals was the work of the Government, and might therefore be undertaken with a prospect of immediate loss for the sake of the general benefit to the country. No private company could exist on such a basis as that, and it is to individual enterprise that the matter is referred in this country. Animal power will therefore remain until the use of steam can be made at a less cost, whatever the result to the canals. Now, this appears to have already been done on the Erie Canal in two ways, for in the case of both the cable and the steamer companies we have figures assuring us of success, and a certain number of boats running with

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what are claimed to be large profits. Nevertheless, there is the stubborn fact that the number of steamers between 1875 and 1878 only increased by three or four, while the cable system, after an existence of nine years, extends over less than a third of the canal. This demonstrates conclusively that neither of the methods meets general approbation, although they are not thus proved to be failures. Their cold reception may be a repetition of the experience which attended the introduction of steam in general navigation, and their future may be as brilliant.

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UNDERGROUND HAULAGE IN THE COAL-MINES OF PENNSYLVANIA.*

BY H. V. FURMAN ('81) AND A. E. SWAIN ('81).

[COAL, as a cheap mineral of fluctuating market value, can be mined with profit only on a large scale. Large areas must be opened at once to secure the necessary output; and as the workings advance rapidly, the distances over

* Abstract of a memoir forming a part of the work of the Summer School of Practical Mining.

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which the coal has to be hauled increase at equal rate. The question of transportation becomes of great importance, as the saving of a few cents a ton may mean profit instead of loss, success instead of failure.

Tramming by man-power as in the metal-mines, is manifestly out of the question. For short distances and moderate outputs the cars are usually drawn by mules, and as the distance or the amount of coal increases these are replaced by small mine-locomotives of compact design, adapted to the low and narrow gangways of the mines. In some cases, owing to defective ventilation or to the presence of fire-damp, locomotives cannot be used. In such cases stationary engines may be employed. The following memoir gives some interesting details of these different methods of haulage, as observed by the writers in several mines visited last summer:—ED.]

HAULAGE BY MULES AT THE "SOUTH SIDE" MINE OF THE "WESTMORELAND COAL COMPANY."

There are three main entries, and altogether eleven miles of road in this mine. The maximum grade is 3½ feet to the 100 feet. The ruling grades in the main entries are 0.5 feet in 100 feet, 0.2 feet in 100 feet, and 0.8 feet to the 100 feet. The first and last are against the traffic, and the second in favor of the traffic. The gauge is 40 inches.

Iron rails of I-section and of the following weights are used:

Outside.....	24 lbs.	to the	yard.
In main entries.....	20 "	"	"
In butt "	16 "	"	"
Partings.....	12 "	"	"

The mine-wagons used are built of white oak, bound with strap-iron. They weigh 1,000 pounds, and their capacity is 3,000 pounds, although 2,800 pounds is considered as the

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maximum load they should carry. They cost from $28 to $30, and last about three years.

Four to six loaded wagons are hauled per trip. There are eleven drivers, and each driver averages 55 tons a day. At present they are using eleven mules, and an extra one in case of necessity. Repairs to tracks cost $8 per day. Cars are oiled by a boy, who is paid 90 cents per day. At present they are using 100 wagons, and the cost of repairs of wagons is $3 per week.

HAULAGE BY LOCOMOTIVES AT THE "NORTH SIDE" MINE OF THE WESTMORELAND COAL COMPANY.

The locomotive takes in twenty-eight empty cars per trip, a distance of one and three-fourths mile, up grade all the way. The steepest grade is 3½ feet to the 100 feet. The sharpest turn is a curve of 40 feet radius, the grade being 2¼ feet to the 100 feet. The wagons are taken back into the rooms by mules, six being required for this purpose. The wagons are the same as those used in the "South Side" mine. The gauge is 40 inches, and the rails used are 24 and 30 pounds per yard, although the 24-pound rails are considered too light. The car-wheels are self-oilers. Much trouble is experienced with slippery rails, no less than three bushels of sand being used on the tracks per day. This causes excessive wear on the locomotive tires, which have to be turned frequently. The car-wheels also wear rapidly, chilled wheels lasting about a year only.

The dimensions of the locomotive, made by H. K. Porter & Co., of Pittsburg, Pa., are as follows: cylinders, diameter, 8 inches; stroke, 14 inches; four drivers, 26 inches diameter; wheel-base, 5 feet 3 inches; length over all, 14 feet 3 inches; extreme height, 6½ feet; weight, 19,000 pounds. The hauling capacity of the locomotive is, on level, 385 tons; on grade of 40 feet per mile, 125 tons; grade 100 feet to the mile, 55 tons.

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The following table gives the comparative cost of hauling by mules and locomotives at the "North Side" mine:

Cost of improvements necessary for introduction of locomotive haulage.

Ventilation account, fan, engine, boiler, etc.		$1,527 00	
Cistern, wells, and pipes		1,261 46	
Locomotive, cost	4,500 00		
" stack	10 00		
" house	275 00		
		$4,785 00	
Wagons, new brakes and couplings		527 00	
Permanent way, new track required		1,659 00	
Extra timbering		240 00	
Grading entry		1,015 00	
			$11,014 46

Cost of delivering 63,589 tons of coal into cars at Irwin Station, during 14 months, using locomotive for hauling coal.

Interest, repairs, and depreciation of permanent way, costing $4,025.46		$881 70	
Interest, repairs, and depreciation of locomotive* and improvement to rolling-stock, costing $5,312		1,203 57	
Interest, repairs, and depreciation of improvement to ventilation, costing $1,527		272 67—	$2,357 94
Labor for 160 days, at $57.20		9,152 00	
Feed for 6 mules, 14 months, at $13		1,092 00	
Fuel, 160 days, 40 cents		64 00	
Oil, waste, and sand, 160 days, 30 cents		48 00—	10,356 00
Interest and depreciation on six mules, 14 months		280 00—	280 00
Total			$12,993 94

Or, a cost of 20.4 cents per ton of coal hauled.

Cost of hauling the above, using mules all the way.

Interest and depreciation of 20 mules, 14 months		$933 34	
Labor, 160 days, at $63.60		10,176 00	
Feed for 20 mules, 14 months, at $13		3,640 00—	$14,749 34

Or, a cost of 23.2 cents per ton, which shows a difference of 2.8 cents per ton in favor of locomotive haulage.

* Repairs to locomotive in hauling 63,000 tons of coal, $237 46

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HAULAGE BY TAIL-ROPE, "SOUTH SIDE MONONGAHELA" MINES OF THE BIRMINGHAM COAL CO.

The coal is hauled from the pit to Spiketown, where the surface works are situated, a distance of 2,425 yards, by a stationary engine worked on the "tail-rope system." A portion of the coal is taken from Spiketown to Twelfth street, Pittsburg, S. S., by a locomotive. The remainder is transported to Twenty-first street by another tail-rope, through a tunnel two miles in length. The "tail-rope system" consists of two ropes, a full and a tail rope, wound on two drums, working loose on a single shaft of the stationary engine, each drum being alternately thrown into gear by independent clutches. The drum is 6¾ feet in diameter. The tail-rope passes from the drum on rollers back into the workings, where it passes over a sheave and back to the mouth of the pit, and is here fastened to the front end of the empty train going in The full rope passes from the drum over rollers to the rear end of the train, to which it is fastened.

The tail-rope drum is now thrown into gear, the full drum working loose on the shaft. The engine now being started, the tail-rope is wound on the drum and pulls the train into the workings, pulling the full rope, which unwinds from the full drum, after it. From the mouth of the pit to within six hundred feet of the sheave there is a single track; from this point back to the sheave there are two tracks. The empty train coming in is switched off to the right-hand track. The engine is stopped, and the cars are taken back into the rooms by mules. The tail-rope is then fastened to the back end of the loaded train, which is already made up on the left-hand track, and the full rope to the front end. The engineer is now signalled by telephone, and the drum-man throws the full drum into gear and the tail-drum out of gear.

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The cars are the same as those previously described, except that they are not provided with brakes. Sixty to sixty-five cars are hauled per trip. The time of running from Spiketown to the sheave is thirteen minutes, and the time out is the same. The distance has been run in nine minutes, but the cars are liable to be thrown from the track at this speed. Sixteen trips a day is as many as can be made. At present they are making fourteen trips. The gauge of the track is forty inches. Where the tail-rope is in operation a twenty-pound rail is used. There is no regular grade, it being up and down all the way in. The heaviest grade is two feet in one hundred feet, and the average grade six inches in one hundred feet. The sheave is forty-two feet below the mouth of the pit at Spiketown. This makes the strain on the rope and also the speed very variable. There are no curves on either of the planes, although they are now extending the plane back into the workings eight hundred yards farther, and there will be one curve near where the sheave now is. Steel ropes seven-eighths of an inch in diameter, made by Roebling, of New York, are used. The full rope has been in use seven years, and is still good; the tail-rope has been in use nine years, but it must soon be replaced. When the rope becomes too much worn for a full rope, it is used for a tail-rope. There are two engines: one situated at Spiketown, which operates the system running from Spiketown to the workings, and one at Twenty-first street, which operates the system running from Spiketown to Twenty-first street. Both engines are eighty horse-power, stroke thirty inches, diameter of cylinder fourteen inches, and are run at eighty pounds pressure. The sheave is six feet in diameter. The rim and axle of the pulleys is made of cast-iron and the centre of white oak or locust. The average distance between the rollers is eighteen feet. The rollers are supported on the ties between the track.

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HAULAGE AT THE "CROSS CREEK COLLIERIES" IN THE LEHIGH ANTHRACITE REGION.

Mules are used here principally for distributing the cars to the working-places from a central station, going short distances only. The empty cars are taken down and the loaded cars brought to the surface, or to the foot of the slopes, by locomotives. The rails used are as follows:

65-pound rail used on the surface.

45-pound rail used on the locomotive roads.

40-pound rail used on the slopes.

30-pound rail used in the main gangways.

25-pound rail used in the breasts, etc.

Gravity roads are used whenever it is possible, for both full and empty cars. The steepest grade on these gravity roads is 7°, and for short distances only; the least grade, 1°. The steepest grade where mules are used is 10°. It is hard work for one mule to pull an empty car up this grade. The steepest grade where the locomotive is used is seven feet in one hundred feet.

The mine-car used is rectangular in section, the frame being built of timber bound with strap-iron. The bottom and sides are of one continuous piece of sheet-iron bolted fast to the framework. The capacity of the cars is two tons, and they weigh about a ton. They are very strong and durable. The cars are not provided with brakes, "sprags" being used for this purpose. In the "No. 1" workings, there were formerly eleven hundred yards of gravity roads in operation, but these have lately been shut off by a fall of the roof. Formerly the locomotive took the empty cars in a few hundred yards; they were then uncoupled and run back to the breasts, where they were loaded and then run around to the bottom of the slope by gravity. At present the locomotive takes the cars in a distance of thirteen hundred yards (down grade all the way); they are then run

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back on the counter gangways to the breasts by mules. All the cars are now brought to the surface by mules and the locomotive. The locomotive brings out from four to eight loaded cars at a trip. The heaviest grade coming out is seven feet in one hundred feet for a distance of five hundred yards. The locomotive makes about thirty-six trips per day, averaging seven cars per trip.

WHAT IS THE CAUSE OF ISOMERISM IN THE AROMATIC SERIES?

BY L. H. FRIEDBURG, PH.D.

CHEMICAL theories, if they are judiciously formulated, unite in a whole, facts that it would otherwise be difficult to master. They give us a vivid impression, without which we would view naked facts as inanimate figures.

Such theories, having for their foundation practical observations agreeing with them, in their turn induce the discovery of other facts, which either support and extend them, or conspire to their destruction.

In this orbit moves also the beautiful theory of the aromatic compounds, which, almost twenty years ago, was established by *Kekulé*.

The idea that serves as its fundamental principle—the combination of six tetravalent carbon atoms, in benzene and its derivatives, to a ring—has sustained itself to the present day, and overwhelmed chemistry with new results. It has, at least, had this practical effect, if it has not, so far, led to the discovery of an unknown natural law.

The main idea of *Kekulé*, the ring-formed combination of the six carbon atoms in benzene and its derivatives, has

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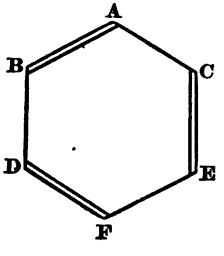
so far not been upset by any facts observed. But, *the manner in which* the six carbon atoms are combined with one another has, in the course of time, led to an exchange of opinion among chemists* engaged in the study of isomerism in aromatic compounds.

In the original hexagon of *Kekulé*, isomerism must be exclusively referred to the *position* which the elements or residues† introduced into benzene in the place of hydrogen atoms, occupy with respect to one another.

The substitution of hydrogen atoms, adjacent, opposite, or occupying a middle position, is regarded as cause for the existence of three isomeric doubly substituted derivatives.

As, in the original formula of *Kekulé*, two consecutive carbon atoms never have the same number of bonds between them as exist between them and their adjacent carbon atoms, there can be no referring to the binding of the carbon atoms among one another as a cause for the appearance of isomerism, else we could always, for doubly substituted products, predict five instead of three isomerics, while experimental researches always show three.

If position be regarded as cause of isomerism, we find:



A C=A B=first position (adjacent).
A D=A E=second " (middle).
A F= third " (opposite).

Corresponding to three positions, three isomerics. If, however, the bonds between the carbon atoms be consid-

* Such as: Claus, Dewar, Erlenmeyer, Graebe, Hübner, Ladenburg, Liebermann, Kekulé, V. Meyer. Städeler, Wichelhaus, etc.

† Hydroxyl=OH=water residue, amido=NH_2=ammonia residue, nitro=NO_2=nitric acid residue, etc.

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ered in addition, or alone as cause for isomerism, we would find :

A B=first position (adjacent),
A C=second " "
A D=third " (middle),
A E=fourth " "
A F=fifth " (opposite)—

that is five positions, corresponding to five isomerics.

But more and more we were led to the idea that the bonds had a more important part to play in the phenomenon of isomerism, than *Kekulé* originally ascribed to them.

It was proved that there existed in *pairs* two different kinds of *equal* positions, and one, quite peculiar fifth position every time that we want to transform monosubstitutional products into polysubstitutional ones. Hence, each carbon atom belonging to one of these pair-positions must sustain a similar relation to all the other carbon atoms.

But among these relations, it must be granted, there stands first the arrangement of the bonds.

Of the very numerous possible formulæ for the arrange-

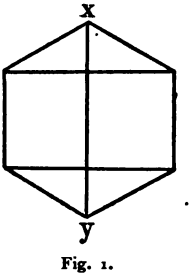

Fig. 1.

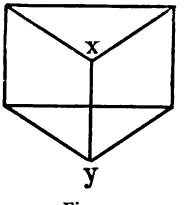

Fig 2.

ment of bonds, by means of which the six tetravalent carbon atoms can be shown as tied together, in the course of time the following two have remained in use (Figs. 1 and 2), and to some extent this third one (Fig. 3), while *Kekulé*, not laying too much stress on the arrangement of the bonds, though fully appreciating the force of the formulæ above

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given, prefers mostly his formula originally given (Fig. 4) because of its easy explanation of the formation of benzene out of acetylene, and moreover of mesitylene ($C_6H_3(CH_3)_3$) out of acetone ($CH_3\,CO\,CH_3$).

The formula No. 2, invented by *Claus*, and very strongly defended by *Ladenburg*, is to be understood in a stereometrical sense, and is known by the name of "prism formula."

In these formulæ, in order to be consistent, we are obliged

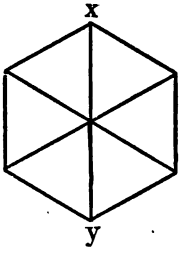

Fig. 3.

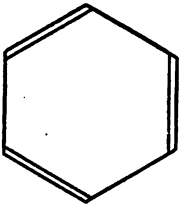
Fig. 4.

to regard, besides the arrangement of the bonds, the *distance* of the carbon atoms from one another as influencing the phenomenon of isomerism.

In all three formulæ (Nos. 1, 2, 3) the carbon atom x has a single bond between it and three other carbon atoms, and with two others it is bound indirectly.

Adjacent and opposite may hence in this case be called near and far,* from which it may be concluded, that position x, y, which is unparalleled in its way, must be due to a smaller or greater distance of these two carbon atoms from each other, with a single bond between.

Hence, what we understand by position, we see defined by number of bonds and distance.

Here we might rest satisfied and consider the question as to the grouping of the carbon atoms in benzene as sufficiently discussed.

* For the prism, Ladenburg gives another reason.

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But it must be specially stated that the existence of the so-called addition-products, such as hexachlorbenzene ($C_6H_6Cl_6$), etc., reduces all these formulæ to a single one, namely, to the plain hexagon, in which each of the six carbon atoms is connected simply with the two adjacent ones :

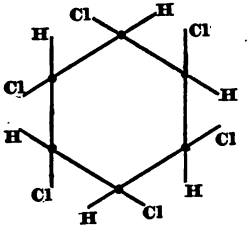

Fig. 5.

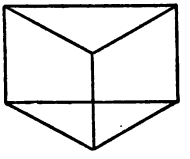

Fig. 6.

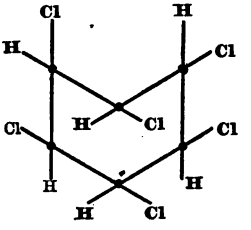

Fig. 7.

The process by which we, according to our understanding, shall, for instance, after expulsion of the six added chlorine atoms in hexachlorbenzene, again get the old arrangement of bonds, particularly for the restoration of the prism, remains very incomprehensible.

Besides other reasons, it is this elaborate changing of the arrangement of bonds in the original form and the returning to the old, after taking away the six monovalent elements or residues, which makes another graphic representation desirable.

Such a new representation as to the manner in which the carbon atoms may be bound together in benzene and its derivatives, I intend to develop in the following.

This conception introduces the idea, which has often been pronounced, but never brought forward in this manner, that the carbon enters into combinations not as *atom*, but as *molecule*.

No observation, not even the vapor density, gives us any decisive clue in this matter. Carbon cannot be made to assume the gaseous form.

On the other hand, however, the physical properties of carbon, its atomic heat, which, according to *Weber* and

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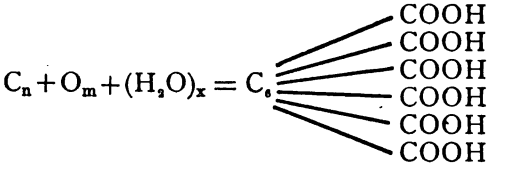
Kopp, is different for different temperatures and for its various combinations; furthermore the fact, that we can oxydize it directly to mellitic acid:



Mellitic acid.

lead us to suppose that the carbon molecule consists of more than two atoms.

I will assume, that the carbon molecule, or that fragment of it which enters into chemical combination, consists of four tetravalent carbon atoms, that hence the atomic weight of carbon would be equal to 3 (Hydrogen = 1), its molecular weight equal to 12; and now let us see to what con-

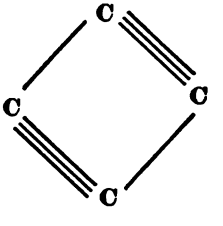
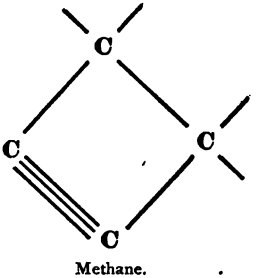


Fig. 8.



Methane.

Fig. 9.

clusions this supposition leads regarding the constitution of benzene.

One simple way of connecting by bonds the carbon atoms in the above mentioned carbon molecule, is this (Fig. 8):

In marsh-gas (methane) in which we can suppose it as a tetravalent whole, the bonds may be arranged thus (Fig. 9):

While the following formulæ, consisting of two carbon molecules, already show the tendency to opening and form-

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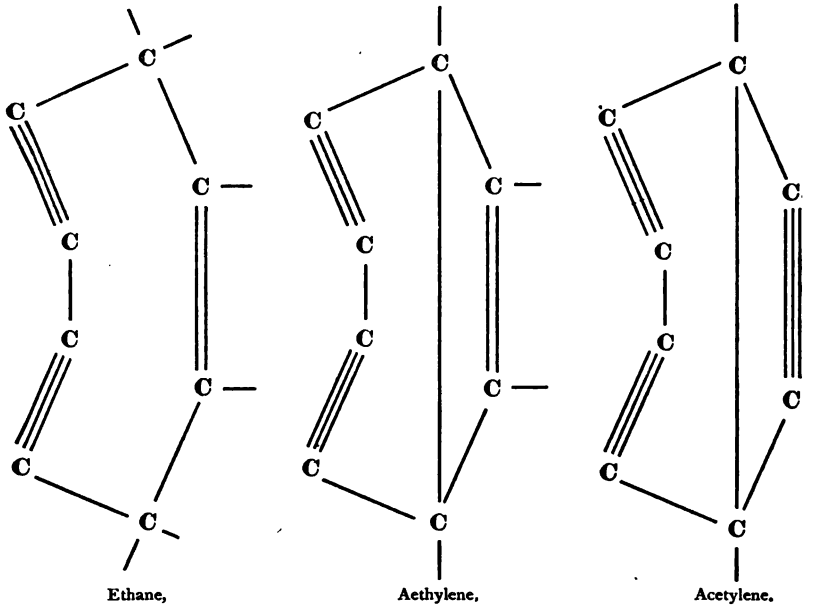
ing a ring, and might serve as graphic formulæ, for Ethane, Aethylene, and Acetylene.*

We see that the number of bonds between two carbon molecules increases from ethane to aethylene to acetylene, as 3 : 4 : 5.

In benzene the binding between two carbon molecules



Ethane, Aethylene, Acetylene.

cannot be quite so compact as in acetylene, out of which we can form the benzene.

Keeping in mind that three acetylene molecules form one of benzene: $3(C_2H_2) = (C_6H_6)$, and supposing that carbon atoms drawn in the hexagon opposite to each other correspond to a former acetylene molecule, then we can construct the following graphic formula for benzene. (See Fig. 1, Plate III.)

* We see by these figures, that we can easily suppose the existence of an isomeric ethane, as well as an isomeric aethylene and acetylene. But if we admit the ring-formed combination as being the most natural between two or more carbon molecules, the existence of such isomerics becomes doubtful.

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In the figure, six carbon molecules, each of which consists of four atoms, bind six hydrogen atoms, and we still find remnants of the old arrangement of bonds, as we supposed it, in the acetylene molecule.

To make matters more plain, I have in the drawing provided with numbers the carbon atoms belonging to one carbon molecule, and *only* those atoms of different molecules, marked with the same numbers, are to be conceived as bound together.

Thus atom 1 of molecule A binds the atoms 1 of molecules C, E, and D; atom 3 of molecule A binds the atom 3 of molecule D; atom 4 of molecule A binds the atoms 4 of molecules B and F, and so on.

Fig. No. 1, Plate III., shows the drawing in plan in detail. Fig. No. 2 is the same drawing simplified, it being understood that there must be supposed to be at each angle of the hexagon a carbon molecule consisting of four carbon atoms, bound however, as in Fig. 1.

Fig. 3 gives us a stereometrical presentation of this same arrangement of bonds.

It will be seen that we have been led to the form of a four-sided double pyramid, which need not of necessity be octahedron.

In our figure, the carbon atoms corresponding to the polar positions (A D) are bound together threefold, those corresponding to adjoining positions are doubly bound (A F and A B), whereas a single bond marks the middle positions (A E and A C).

The *form* remains the same for the addition products, only it must be imagined that one internal bond (3 : 3 for instance) in the direction of the axes between every two carbon molecules breaks, and these then serve as bonds for the monovalent atoms, or residues, to be added.

Hence this figure, at least, is not open to the same objection as the prism, which we must imagine as reduced to a hexagon by the formation of addition products and allow

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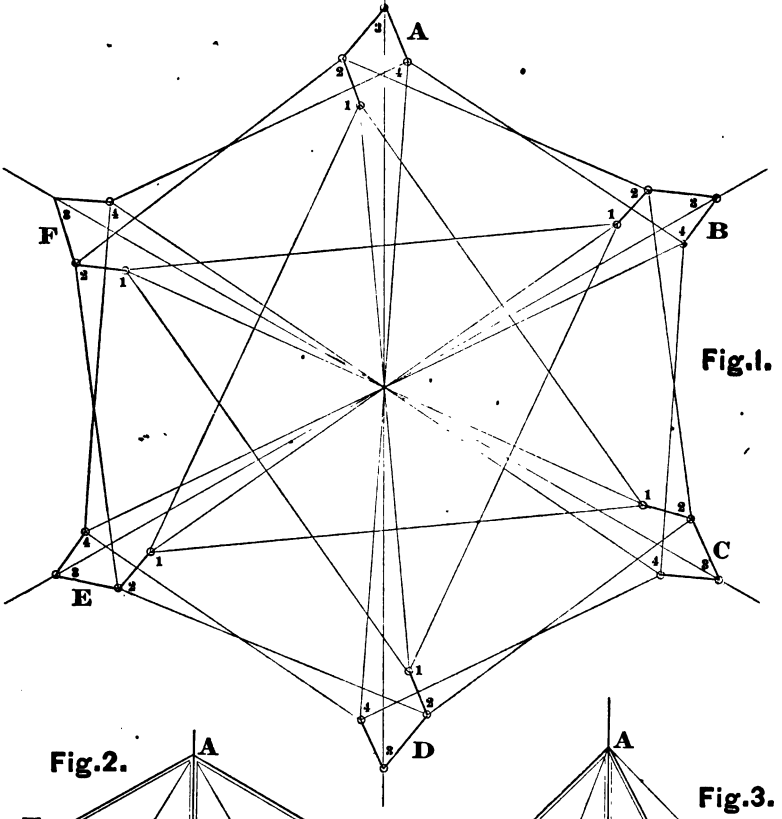

Fig.1.

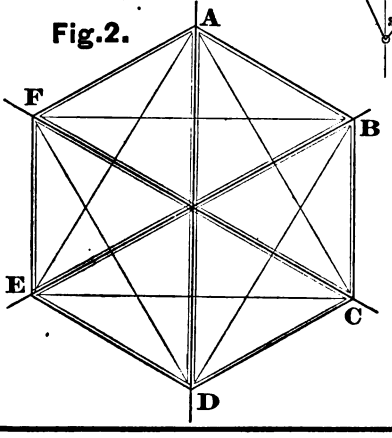

Fig.2.

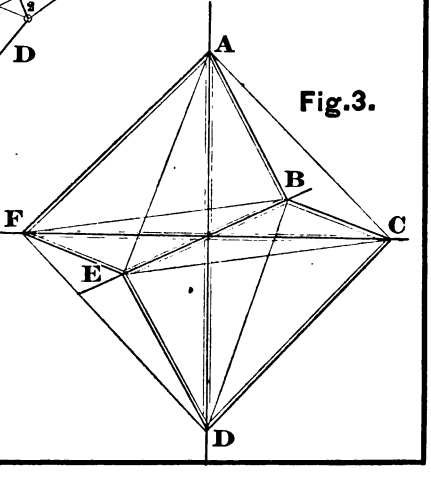

Fig.3.

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it to become a prism again, when we take the addition away. A careful investigation will show all known facts in regard to the phenomenon of isomerism to be in accordance with the new form given, *if we accept the arrangement of bonds between those of the carbon molecules where hydrogen was replaced, as the most vital feature of this phenomenon.** Position and distance, if at all taken account of, can only be looked at as items of secondary importance.

To show, by a simple example of double substitution, how the arrangement of bonds may be considered as the reason for the phenomenon of isomerism, let us suppose that in any of the figures given on the plate annexed, substitution has taken place at A.

If we now replace another hydrogen atom, this can be done, *and can only be done*, in three different ways:

1. A F=A B—double bonds.
2. A E=A C—single "
3. A D triple "

In a future paper I will establish the efficiency of this figure, and of the reasons that lie at its foundation, by examples taken from the manifold and striking phenomena of isomerism in the aromatic series, also considering the higher and highest substitution products.

For the present I remark expressly, that I cannot depart from the figure given, that, for instance, I am not allowed to bind together the carbon atoms 1 and 4 of one and the same carbon molecule.

Furthermore, the whole opinion advanced would be untenable as soon as one should conclude from the same, that the carbon atom be *trivalent*, and that only because the carbon possibly enters into combinations as a molecule of four atoms, it *appears* that the molecule, heretofore regarded as an *atom*, is tetravalent.

NEW YORK, April 19, 1881.

* *Hübner* was the first who pronounced in the most distinct manner this possibility, but he did not give a figure which supported his meaning sufficiently.

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PROFESSIONAL NOTES.

Analytical and Applied Chemistry.

Determination of Sulphur in Lead.—W. B. Kunhardt, '80, writing from Clausthal, Germany, where he is studying mining methods, sends the following note for the QUARTERLY. The method, he states, is original with a certain Dr. Wunderlich, of Clausthal.

Treat twenty to thirty grammes of very fine chips of lead with an excess (considerable) of concentrated hydrochloric acid; sulphur will be set free in the form of sulphuretted hydrogen. Pass the sulphuretted hydrogen, by means of an aspirator and purified air, into bromine water, in which it is decomposed, sulphuric acid being formed. Determine sulphur in the latter by barium chloride, as usual. The results of this method have proved very satisfactory. The solution of the lead is aided by gentle heat. A large excess of hydrochloric acid prevents the separation of lead chloride. In the experiments a small brown-black residue was often formed, which could not be dissolved. To test it for sulphur, the supernatant fluid was poured off, the residue washed on a filter with boiling water, then dried and fused with saltpetre and soda. In no case was sulphur found with the residue, but silver chloride, antimony, lead, iron, and traces of copper were found in it. In the "merchant lead" of the Clausthal smelting works 0.001322 per cent. of sulphur was determined by this method. The same principle is involved as in the determination of sulphur in coal-gas.

Chloro-bromide of Lead.—A sublimate formed as a furnace product in the treatment of lead ores has been examined and described by M. W. Iles ('75), chemist and assayer to the Grant Smelting Works, Leadville. Soluble in warm water. Sublimes on charcoal giving a white coat, in a tube sublimes giving oily drops. Density, 5.741. Composition:

	Found.	Theory for PbBrCl.
Pb	63.729	64.186
Br	25.321	35.814
Cl	10.345	
	99.395	100.00

Br : Cl = 1. : 0.92.

—*Am. Chem. Jour.*, *March*, 1881.

For Coloring Toys, a law in Germany prohibits the use of all colors containing any admixture of compounds of As., Cu., Pb., Hg., Bi., Sb., Sn., Zn., and the chrome acids. The effect of the law (which was naturally strenuously opposed by the toy manufacturers) has been to cause experiments to be made with a view to introducing colors not proscribed by the law. The Chamber of Commerce and Industry at Sonneberg have recently published a list of colors

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which may be used. The paints in this list embrace 3 kinds of white, 11 of red, 6 of yellow, 8 of green, 2 of violet, and 4 of blue. It is expected that the list will be much extended in time.

Refined Petroleum, not standing a fire-test of over 110° F., will hereafter not be admitted into Germany as an import. The tests are to be made by Government experts in the custom-house. The tester most highly recommended by the Government commission appointed to investigate the subject, is that of Bernstein, so arranged that a small taper is lighted if the oil evolves an inflammable vapor at the temperature fixed as the limit. Mr. Bernstein was at the School of Mines a short time since, and gave an exhibition of the working of his apparatus before the students of the third and fourth classes.

An Examination of the Fire Clays and Rocks at Golden, Col., has been recently made at the State School of Mines, Golden, Col., with the following results:

	Steel Blue Clay.	Cretaceous Limestone.	Jurassic Sandstone.	Green Jurassic Sandstone.	Sandstone between Triassic and Jurassic Rock.
SiO_2	52.41	2.06	77.26	4.91	89.16
Al_2O_3	32.21	....	4.76	....	5.49
Fe_2O_3	0.66	0.56	0.50	0.34	
CaO	0.20	....	...	....	....
MgO	0.06	....	....	....	....
K_2O	0.61	....	....	....	....
Water	14.05	....	....	....	....
Carbonate of Lime	....	96.62	15.85	92.62	2.68
Carbonate of Mg.	....	0.52	1.20	2.34	1.57
	100.20	99.76	99.57	100.21	98.90

—*Am. Manufacturer, Pittsburg, Pa.*

The Sugar Industry of Hawaii is now the leading industry of that group of islands. The cane grows wild on the islands as well as on other islands in the Pacific. The first sugar was manufactured there in 1802, again in 1819, and again in 1823, but the first systematic attempt to make it one of the industries of the country was in 1835, by an American firm, Ladd & Co. In 1851 the first centrifugal drying-machine was introduced, which produced a marked improvement in the quality of the product. By 1857, on account of low prices and a growing scarcity of labor, the number of plantations had much diminished, but a new impetus was given to the industry by the introduction of steam power in driving the machinery in 1859. The vacuum-pan was introduced two years later. The reciprocity treaty of 1876 with the United States revived the industry, which had begun to languish a few years before on account of the

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high duties of the United States custom-house and the high price of labor. The exportation in 1879 amounted to over 25,408 net tons. The amount for 1880 has been estimated at nearly double that figure. At present over 23,000 acres of land are under cultivation for the sugar crop. From four to five tons of sugar per acre is the usual yield. The juice ranges in gravity from 7° to 10° Be. The soil, consisting of decomposed lava, appears to be especially favorable to the growth of the cane, and does not seem to be exhausted by long cropping with sugar-cane.—*U. S. Consular Reports, No.* 4.

Manufacture of Nitro-Glycerine.—The method of making nitro-glycerine followed at the French Government powder-mills, at Vonges, is apparently a great improvement on the processes in use in this country. In the Hill-Mowbray process, and in the method used by the Atlantic Powder Co., great care has to be exercised in running the glycerine into the mixed acids, that the heat developed by the reaction may not raise the temperature of the mixture above a certain limit of safety. To this end the glycerine is run in drop by drop, and the mixing vessel kept cool with ice or ice-cold water. At Vonges, this danger and trouble is most happily avoided by mixing the glycerine with one portion of the sulphuric acid, and the nitric acid with another portion, and allowing these mixtures to cool before finally combining them for the production of nitro-glycerine. One hundred kilos of glycerine are mixed with 320 kilos of sulphuric acid, and 280 kilos of nitric acid with 280 kilos of sulphuric acid. The mixtures are allowed to cool and then simply poured into ten stone-ware pots, 42 kilos of glycerine and acid, and 56 kilos of mixed acid, to each. The pots are covered, the lids being provided with vents for the escape of any gases that may be developed, and the reaction is allowed to go on over night. The next day the nitro-glycerine formed is washed as usual. The yield of nitro-glycerine by this process is larger than that obtained by other methods, and the product is very pure.—*Prof. Chas. E. Munroe, Proc. U. S. Naval Inst.*

Economic Geology and Statistics.

Petroleum in Roumania is obtained by very primitive methods of working. Wells from two hundred to four hundred feet are dug, and the petroleum slowly filters into them through the strata. A very good well yields one hundred and twenty gallons per day. Eighty gallons per day is considered moderate. The well usually ceases to yield when a year old. The production in 1873 was 3,837,000 gallons. With the introduction of the American product into foreign markets the amounts have decidedly decreased. Refineries exist at Ploiesti, Galatz, Braila, and Bucharest.

The Petroleum of Galicia is refined by an American, Mr. James Carrigan. More difficulty is experienced in boring for it than in the case of the Pennsylvania petroleum, and, though heavier in gravity, it gives much more trouble in refining. The annual production is put at one hundred thousand barrels.

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Mining and Metallurgy in Sweden.—During the year 1879 the number of iron mines worked was 426; the blast-furnaces numbered 182; the average number of days each furnace was worked during the year being 193; the number of steel-works was 27. The product in metals, etc., for the year, calculated to our weights, was: pig-iron, 377,589 tons, net; steel, 30,457 tons; gold, 84.8 oz. Troy; silver, 34,357,5 oz. Troy; copper, 17,929 cwt., net; refined nickel, 118.4 cwt.; pig-lead, 5,311.6 cwt.; sulphur, 6,267.5 cwt.; coal, 97,684 tons, net. The coal is quite hard, requiring a strong draught. As yet it has been used only in locomotives and furnaces.

The Kauri Gum of New Zealand, long considered a fossil resin, is the solidified sap of a species of pine known as the *Demerara Australis*. The tree grows to a height of one hundred and fifty to two hundred feet. The wood is very hard and susceptible of high polish. The district in which this tree grows is exceedingly small. The largest proportion of the gum exported is dug from the ground, where formerly large kauri-pine forests flourished, which has given rise to the impression that it is a fossil gum. When the search is made for the gum below the surface of the ground, the gum-digger feels for it with a long iron spear pointed at the end, judging by an instinct born of long practice whether his spear touches a stone or a piece of gum, when it encounters any resistance. When the gum is taken from the tree, gashes are simply made in the bark, from which the sap flows, which dries and hardens on exposure to the air. When the tree is felled the stump bleeds in the same manner, and when the gum has hardened sufficiently the masses are broken off for the market. When first exported about one hundred tons per annum, at twenty-four to twenty-eight dollars per ton only, were sent to market. The amount exported in 1880 was about fifty-five hundred tons, at the average price of $216 per ton, though the price varies from $144 to $720. Of the amount exported more than two-thirds went to the United States. The Government has taken no steps to protect the trees, and there is a serious danger that the kauri forests will soon be entirely destroyed.—*U. S. Consular Reports, No.* 4.

Mining Engineering.

Underground Haulage by Locomotives.—In the paper on this subject, in the present number, was noticed the wear of locomotive-tires and car-wheels, from the excessive use of sand rendered necessary by slippery rails. This trouble is a common one, and met with in nearly all coal-mines where locomotives are used. An extract from a letter recently received from Drifton gives a simple means of overcoming the difficulty:

"We have been using for a long time a jet of water, instead of sand, on our steep up-grades. The locomotive pulls the full cars up a grade of three feet in a hundred. In the mines the rail gets covered with a fine slime of coal-dust, water, oil, lamp-black, etc., and it is almost impossible to get good results with sand, as that does not clean the rail as water does. E. B. Coxe."

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In a paper* on the use of underground locomotives at the Doman Collieries, in the Hungarian Banat, the author, C. Heinrich, describes the successful employment of the same device. A jet of hot water from the boiler is allowed to squirt on the rails immediately in front of the driving-wheels, the effect of which is to clean the rails completely from all slime, and in winter to remove ice and hoar-frost as well. At these mines the grade of the track is with the traffic, but on the return trip the locomotive has to haul in sixty empty cars, a total weight of twenty-two tons, up a grade of five feet in one hundred feet.

Experiments on a narrow-gauge road in France show that wet rails have a lower coefficient of friction than when dry. On a grade of 7½ feet in one hundred a locomotive of 7½ tons hauled 7½ tons of load in wet weather as against 9.7 tons in dry weather. The difference, however, is not great, and as it is rarely possible to have a dry line of rails underground, the clean-washed rail seems to be preferable. H. S. M.

Compressed-Air Mine Locomotives.—The principal objection to the use of locomotives underground lies in the necessity for abundant ventilation to carry off the products of combustion. Several accidents have occurred, and lives have been lost, by suffocation with carbonic oxide gas, through insufficient air-current in the locomotive gangways. As it is dangerous for the locomotive to approach too near the working-places, it is found necessary to use mules to distribute the empty cars and to collect the full ones into trains to be taken out by the locomotives. Compressed air, although a more expensive motor than steam, offers great advantages, not only in being safer, but also as dispensing with the weight of coal and water, fire-box, water-tank, etc., it enables us to build a very much lighter locomotive, well adapted to replace mules in the work of distributing empty cars and collecting the loaded ones.

A report recently made by Messrs. Gilchrist & Talfers, to the West of Scotland Mining Institute,† gives the details of a successful application of compressed-air locomotives to underground haulage at the Newbottle Collieries.

At one mine there are four small locomotives in use, weighing less than a ton (15 cwt.). Each of these locomotives do about the work of one mule, hauling four empty cars (of 6 cwt. each) up grades of five and one-half feet to seven and one-third feet in one hundred feet.

The locomotives are of the simplest possible construction, consisting of a tank of twenty cubic feet capacity, mounted on wheels, with two horizontal cylinders below, 3 inches diameter by 6 inches stroke. The slide-valves are worked by loose eccentrics, to reverse which it is necessary to push the locomotive backward on the rails for half a revolution of the wheels.

Air is used at a pressure of two hundred pounds to the square inch. The tanks of the locomotives are filled from air-mains running along the gangway.

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* Zeit. des Berg und Hüttenmannischer Verein für Stiermark und Kärnten, vol. ix., 1877, p. 238.

† Trans. West of Scotland Mining Inst., vol. i., p. 177.

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The charging of the tank takes twenty or thirty seconds, and is necessary after about three-quarters of a mile run. Larger locomotives, holding forty cubic feet, and weighing twenty-seven cwt., are also used, and found somewhat more economical, making a longer run and hauling more cars at a time.

These locomotives have been in use at the mines since April, 1878. At another mine, belonging to the same owner, compressors, etc., are being erected to run thirty locomotives, at an estimated cost of nearly thirteen thousand dollars for the plant and three hundred dollars each for the locomotives. The larger locomotive, mentioned above, costs about five hundred dollars. M.

Ore-Dressing.—The following table of equivalents to Rittinger's standard sieve sizes for ore-dressing work has been computed for the use of the students of the fourth class, and is printed here for the benefit of graduates who may be interested in concentrating works. The smaller sizes of "Nut" and the larger "Pea" sizes correspond more or less exactly with the anthracite coal sizes of the same name.

RITTINGERS' STANDARD SIEVE SIZES (WITH EQUIVALENT WIRE MESH).

Millimetres.	Inches.	Inches.	Wire Cloth.	No. Wire.	Name.
64	2.56	2½	3 in. mesh.	00	Nut. (Stufen.)
45.2	1.80	1¾	2⅛ "	0	
32	1.28	1¼	1½ "	2	
22.6	.90	⅞	1⅛ "	4	
16	.64	⅝	13/16 "	7	Pea. (Graupen).
11.3	.45	7/16	⅝ "	8	
8	.32	5/16	No. 2½ mesh.	12	
5.6	.22	¼	" 3½ "	14	
4	.16	3/16	" 4½ "	15	Sand. (Gries.)
2.8	.11	⅛	" 6 "	16	
2	.08	3/32	" 8 "	18	
1.4	.055	1/16	"12 "	22	
1	.04	1/25	"16 "	25	Meal. (Mehl.)
0.71	.028	1/32	"24 "	28	
0.5	.02	1/50	"35 "	31	
0.35	.014	1/64	"50 "	34	
0.25	.01	1/100	"70 "	38	Dust. (Staub.)

H. S. M.

METALLURGY.

The Thomas-Gilchrist "Basic Process."—Instead of lecturing on this subject himself, Mr. Holley last week introduced to the fourth class Mr. Thomas, of England, one of the inventors of this remarkable process. During the address one was struck not only with the entire mastery of the subject which the speaker possessed, but by his singularly felicitous manner of delivery. Mr. Thomas spoke as follows:

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"I would state to the class, by way of preface, that I wish merely to give an informal chat on the subject of the basic process. It has been found by experiment that the maximum amount of phosphorus allowable in rail-steel is 0.15 per cent.; in tool-steel, 0.03 per cent. It is well known that in the blast-furnace all the phosphorus in the ore will be found in the pig, and it is not likely that we will ever be able to remove any phosphorus in the blast-furnace. For this reason, in the manufacture of steel, the pig used must be made from ores holding less than 0.10 per cent. of phosphorus, as we may say that, on the average, iron-ores contain 40 per cent. of iron. We are then limited to ores holding less than 0.10 per cent. of phosphorus. Of all the ores known to Europe and America only one-tenth fulfil this requirement, and the ores comprising this tenth are unfortunately far removed from the coal-basins. It is in or near these very coal-basins that the largest deposits of iron are found, and it is evident that any process will be of the utmost importanee which can make from these ores high in phosphorus—ores comprising nine-tenths of all known to Europe and America—steel of any given fineness and purity. This is what the basic process actually does."

Mr. Thomas then briefly noticed the Bell-Krupp washing process for removing phosphorus from pig-iron, and continuing, said: "In 1877 it was thought generally, that phosphorus could not be eliminated in steel manufacture; in fact, it was demonstrated by a series of experiments that iron and phosphorus could not be separated at the high temperature produced in the converter. I think, though, that if any one of the gentlemen present had carefully considered these experiments, he would have reached the conclusion that the result arrived at was hardly justified by the experiments. The first experiment tried by us was the introduction of oxide of iron—first as a lining, and second as an addition to the charge. But, before the high heat of the converter, the oxide of iron melted like water, and seemingly had no effect in removing the phosphorus. Naturally we then reverted to lime and magnesia as strong bases and very refractory ones. But another difficulty arose. Not only must the material used as a lining be refractory and strongly basic, but it must have a great resistant power. The lining of the Bessemer converter is subjected to a series of shocks, as it were, from a number of liquid battering-rams. Finally, the discovery was made that if a dolomite, containing seven to ten per cent. of

$$\left\{\begin{matrix} Fe_2O_3 \\ Al_2O_3 \\ SiO_2 \end{matrix}\right\}$$

be exposed to an intense white heat, first CO_2 is given off, and second, a physical change takes place, consisting of a shrinkage and fissuring, and the mass when cool is found to be hard, dense, and heavy. The amount of shrinkage is thirty to forty per cent. of the original volume.

"The ordinary Bessemer converter is lined with radial bricks of dolomite set in a dolomite cement, and the space between the bricks and iron shell is filled with a paste of dolomite and ten per cent. of tar, and rammed tight. The

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bottom is rammed with the same paste, the twyer openings being made by iron rods placed in the bottom. The bottom is then baked at a high white heat.

"An addition of seventeen per cent. of lime is made to the converter, in lumps half the size of the fist. The charge of pig is then introduced. An ordinary iron used contains 1¼ per cent. Si. and 2 per cent. P. The blowing is then done exactly as in the acid process, until the drop of the carbon flame. Then, instead of turning down, adding spiegel, and casting, the blow is continued until the brown flame with white tinge appears, indicating the disappearance of the phosphorus. One remarkable fact is noticed, that, while the smallest percent. of phosphorus remains in the iron, no iron is oxidized and no harm results from an overblow. If we are about starting work on a lot of pig uniform in character, after the converter is turned down, a sample is taken, cast, and cooled quickly. The sample is fractured, and, by the appearance of the metal, a workman experienced in the process can tell within a few tenths of one per cent. the content of phosphorus. The first blow regulated by samples thus taken is accurately timed, and the future blows are all blown on time, no samples being taken. The after-blow lasts on average two to three and one-fourth minutes. The impurities in the pig are consumed in the following order: first, silicon, then carbon, manganese, phosphorus, and finally sulphur. Of course some carbon is going off with the silicon, and so with the others; but the foregoing is the order of disappearance of the last traces of the substances named. The phosphorus disappears as phosphate of lime, and is contained in the slag. Sulphur disappears to the extent of fifty to seventy per cent. of the original content, in the form of sulphides of lime and iron, sulphates, and sulphurous acid. The curious fact now obtains that the more impure the pig, the purer the steel made from it. Another feature in which the basic differs from the acid process is in the introduction, in the basic process, of pig at the end of the blow, thus requiring only half the amount of spiegel to be added."

Mr. Thomas then made some remarks on the manufacture of dolomite bricks, and in conclusion said: "We can get just what we want by the basic process. Iron analyzing 99.8 per cent. Fe. has been made, and the per cent. of phosphorus reduced from 2 to 0.04. The reason why an impure pig gives a better steel is that the excess of impurity gives in its combustion a very hot blow and a very fluid metal. The calorific power of P. is theoretically four-fifths that of Si., but practically P. is more efficient." After paying a tribute to Mr. Holley and modestly disclaiming his own share of honor in Mr. Holley's favor, the speaker ended his discourse. T. B. S.

HARBOR IMPROVEMENTS AT GALVESTON.

GALVESTON, TEXAS, April 12, 1881.

While en route for Mexico I stopped a few days in this city, and, through the courtesy of Col. Samuel Mansfield, Corps of Engineers, U.S.A., was

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enabled to visit the Government work here in progress. The object of this work is to deepen the water in the harbor so that vessels drawing fourteen feet of water can pass over a bar that now impedes and often prevents navigation. At high water there is a scant thirteen feet, and low water is some two feet less. The rise and fall being small, the tides do not run with the velocity and scouring action noticed where this difference is greater. The trouble mainly arises from this fact, and that the ebb tides counteract the work done by the flood in bringing the sand back to its original locality.

Directly north of Galveston is a narrow channel, formed by Bolivar Point (on the north), and the main land; on the west, a large bay of about five hundred thousand acres, and on the east the Gulf of Mexico. Running southeasterly, a bar extends into the Gulf for some ten miles, and when between five and six miles from the main land runs northward; and it is to the clearance of this spur of the bar that the present work is directed. Some fifteen hundred feet from shore (the current having sufficient force to scour and clear the channel for this distance), mattresses sixty feet in length and thirty in width, composed of brush and sunk with stone, are placed in a southeasterly direction, and are to extend outward until the necessary depth of water on the bar is reached.

The making of the mattresses I watched with considerable interest, and could not but notice how peculiarly well they are adapted for the purpose for which they are employed: tough, strong, and pliable, the latter quality being a most important feature, as they can readily conform to the contour of the bottom, thus preventing any underscouring action of the current. Some eight hundred feet from the wharves a pier has been built, where they are made and launched. Portions of the pier decks are in sections, balanced so that when a mattress is finished, by tilting one end of the pier it slides easily into the water. The mattresses are made of a fir-brush, brought, together with stone ballast, some one hundred and fifty miles from the interior, and are composed of fascines or brush-rope one hundred feet in length and about eight inches in diameter. I was informed they were stronger and more tenacious than a hempen cable. These are laid longitudinally about three feet apart, crossed at distances of of five feet with the same material. On this, as a framing, the brush is laid loosely, but evenly, then a tier of fascines, then brush, until they are about four feet in height. When the fascines cross each other strong rope serves to bind them, and at three points in its length an inch and a quarter rope is carried from the bottom row through the brush to the surface, and having at the upper end an iron thimble; and it is by means of these that the mattress is towed to its destination. The fascines are made upon wooden horses, similar to a sawhorse, three feet in height; about every foot is a horse that serves to insure regularity of distance in the tying of the brush together. One man can make about six hundred feet in a day, and this is considered a fair day's work, and a force of sixty men can, in the same time, make three mattresses. All the cord and rope used in their construction are cut in the storehouse on the wharf, of proper lengths, as a preventive against loss by carelessness, compelling care in tying, as there is enough to do the work and no more. The mattress alone costs about

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seven cents per cubic foot, and two cents additional for stone and towing. When finished and launched a powerful tug with light draught is employed to convey them to their future resting-place, where, filled with stone, they sink, being guided by two barges placed on either side. They are laid so as to break joints with each other, as it was found that the sand scoured between the ends when placed so that the ends formed a continuous line. They are given a very easy slope and a beam (*sic*) of at least fifteen feet, so that they can the more readily conform to the bottom. The dike built of these mattresses is often eighty feet wide at the base, and but thirty feet near the surface of the water, but more generally fifty feet on the bed. When the mattresses of this porous wall once become filled with sand they have been found almost immovable and to remain in place and intact after the most severe hurricanes.

At Fort Brown, on the Gulf, and near the Mexican border, these mattresses have done good service, as the peninsula upon which the fort was built was in constant danger from the wearing action of the tides upon the connecting strip of land.

RICHARD A. PARKER, *Civil Engineer.*

SCHOOL OF MINES NOTES.

A number of students of the School are engaged in compiling an "Alphabetical Index to American Engineering Papers and Articles for 1880." The index numbers already more than three thousand titles, and promises to be very valuable to those wishing to look up the literature of any branch of engineering work. The index will be revised and edited by Prof. Munroe, and published by the Institute of Mining Engineers in their Transactions.

Since April 20, 1880, 797 specimens have been added to the Mineralogical Collection, making the number in the whole collection at the present time 14,522, valued at $25,431.55. Included in the additions during the year are 15 species not mentioned before. The collection now contains 603 species.

The large additions are owing chiefly to the purchase of the "How" collection by Messrs. Barney, who presented it to the school, as mentioned in a former note. But few of the zeolites have been added. Many of these are handsome and will add to the beauty of this class of minerals already in the cases, as well as the instructive value afforded by the variety of association and structure.

The Department now has at its command a large number of duplicates, and for these it is intended to solicit exchanges from societies and institutions in Europe and elsewhere, and thus still further increase the value of the collection.

Of the specimens added during the past year, some deserve special mention, as follows, viz. :

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Quartz.—Specimens from several localities have been received, which are interesting on account of their crystallographic forms. From North Carolina, pyramids flattened to such a degree as to nearly obliterate two faces, leaving the other four in the shape of an arrow-head. Some small amethysts and smoky quartz crystals, from the same locality, have slender hexagonal prisms supporting a larger one terminated with a pyramid. From Arkansas, a number of crystals having the faces of a trigonal pyramid and plagihedron.

Phenacite.—A fine specimen from the Katharinenberg locality.

Danburite.—Several specimens, with large crystals, having the basal termination on the prism, from the locality recently described by Prof. Brush in the *American Journal of Science.* Until this discovery this species was found only in little nodules in a vein of oligoclase at Danbury, Conn. Crystals were very seldom found.

Tourmaline.—Large additions have been made to this species, particularly in color: white, from Northern New York, red and green, from Paris and Hebron, Me., and green, from Middletown, Conn.

Sapphirine.—This species, not heretofore represented, has been added by specimens from the Greenland locality.

Calamine.—A large specimen from the Laurium (Greece) mines, of an apple-green color.

Pyrosmalite.—A large crystal of this species, embedded in ripidolite, from the locality in Sweden. It is not so large as the crystal mentioned in Dana as being in the museum at Stockholm, but still is of respectable proportions, measuring 2.5 ctm. in length and the same in breadth across the base of the hexagonal prism.

Saponite.—Specimens of this species have not been in the collection until now.

Celestite.—A specimen of this species from Brown Co., Kan., of a dull red color, deserves attention on account of its color. It was for a time sold as barite, and on the discovery that it was celestite a large advance in the price of specimens followed.

Apatite.—A specimen of this species, of a dark green color, associated with galenite and garnet. The apatite crystal, which is a pyramid and prism, is embedded in the galenite, and has its edges and angles rounded, giving it the appearance of having been fused similar to a piece fused before the blowpipe. It was taken from an iron mine at Andover, N. J.

Cryolite.—Specimens having their surfaces studded with good-sized crystals have been obtained.

Thomsenolite.—Several specimens of this species, with good-sized crystals, along with cryolite, deserve notice.

Magnetite.—A large specimen from Sweden, having crystals of rhombic dodecahedra on the surface, which possess a brilliant lustre.

Pyrrhotite.—The first crystal of this species has been added this yaar.

Huebnerite.—Specimens of this species from the Black Hills, Dak., presented by Dr. Newberry, and determined by the writer, are among the additions.

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Millerite.—Several geodes of calcite, containing downy tufts of this mineral, from the St. Louis locality.

Pyrolusite.—Fine specimens from Tenny Cape, Nova Scotia, show that North America affords as fine specimens of this species as the celebrated foreign locality. One geode is studded with brilliant black crystals.

Rutile.—Fine specimens in elongated prisms, from North Carolina, some not much thicker than a needle, showing how prolific that State is in mineralogical curiosities.

Massicot.—Specimens of this natural litharge disseminated through clay, from Southwestern Texas. This species was not represented before.

Crocoite.—A beautiful specimen of this mineral from the Siberian locality.

Senarmontite.—Half a dozen octahedral crystals of this species from Algeria, measuring from 8 to 10 mm. between the opposite angles of the crystal, are considered fine.

Bornite.—A fine crystallized specimen from Cornwall, Eng.

Atacamite.—A fine vitreous specimen of this mineral is worth noticing.

Euchroite.—Several crystals of this species on mica schist add to the fine display of crystals with which this mineral is illustrated.

The following is a list of the new species added and not mentioned previously, viz: Beudantite, Xanthoconite, Tasmanite, Cyanotrichite, Eucairite, Lagonite, Fairfieldite, Meneghinite, Calaverite, Evansite, Jordanite, Cœruleolactite.

CHAS. A. COLTON.

THE following table has been compiled from the official records of one of the recent graduating classes, with a view to determine the effect of age, if any, upon scholarship:

Age of Students on Entering, October 1.	No. of Students of given age entering.	No. of Students who graduated within 5 years.	No. who failed to graduate.	Per cent. of failures to graduate.
Between 16 and 17 years.....	15	6	9	60 per cent.
" 17 and 19 "	40	23	17	43 "
" 19 and 22 "	11	7	4	36 "
Average age, 18 years.....	66	36	30	45½ per cent.

It will be seen that, of the students entering under seventeen years of age, fully sixty per cent. failed to graduate. The showing would be even more unfavorable did the list include all applying for admission under that age, as only those without conditions are allowed to go on with the class. Those between sixteen and seventeen are, therefore, picked men. The survivors, who finally graduate, are, as would be expected, students of unusual energy and ability, some

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of the brightest men in each class being among those who entered under seventeen years of age. In view of the above facts, however, it would seem that the present limit of age is a wise one, and that it would be inadvisable to open the school to younger students, especially in view of the proposed increase in the requirements for admission.

The advantage of greater age and more mature judgment is shown in the next two lines of the table, the percentage of failures gradually decreasing with the increased age of the students.

The high average of failures furnishes additional testimony, if that were needed, of the fact that the course of the School of Mines does not abound in delicate "roasts," and that to graduate from the school means something.

The following report, recently submitted to the Trustees, will be of interest to those preparing to enter the School of Mines.

COLUMBIA COLLEGE, April 28, 1881.

THE undersigned, members of the committee appointed to consider the expediency of increasing the requirements for admission to the School of Mines, and also to devise a plan for equalizing the amount of study required from the students of the several classes in the School, beg leave to report as follows:

I. As to Admission.

They recommend that from and after the beginning of the year 1882 candidates for admission to the First Class shall, in addition to the present requirements, be examined on

1st. The general principles of *English Grammar*, and on the elements of *Composition* and *Rhetoric*, equivalent to the amount contained in Quackenboss' "Treatise."

2d. *History*, equivalent to Freeman's "History of England" and Patten's "History of the United States."

3d. *Physical Geography*, equivalent to Guyot's "Treatise."

4th. *Free-hand Drawing*, equivalent to the amount now required in the first year.

5th. An increase in the amount of *Algebra*, so as to include ten chapters of Peck's "Manual" instead of five.

6th. An increase in the amount of *Geometry*, so as to include six books of Legendre, instead of five.

They also recommend that from and after the beginning of the year 1883, candidates for admission to the first class shall, in addition to the requirements above specified, be examined on

7th. *Physics*, equivalent to Ganot's "Smaller Treatise."

8th. On the general principles of *French Grammar*, including an ability to read Montmahon's "Cours d'histoire Naturelle" or its equivalent.

9th. On the general principles of *German Grammar*, including an ability to read Hans Andersen's "Märchen" or its equivalent.

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II. As to Equalization.

1st. They recommend that students in Civil and Mining Engineering be excused from attendance on the lectures on *Organic Chemistry*.

2d. That *Qualitative Analysis* be transferred from the second year to the first year.

3d. That the *Quantitative Analysis* in the Chemical, Metallurgical, and Geological Courses be transferred from the third year to the second year, but leaving it for students in Mining Engineering in the third year, as at present.

WM. G. PECK.
W. P. TROWBRIDGE.
C. F. CHANDLER.

IN the last issue of the QUARTERLY a line of figures was dropped from the following table (see page 148), reducing the numbers of students to somewhat absurd fractional quantities. We print the table again, that our readers may make the correction in its proper place in the March number.

	Number of Institutions.	Professors and Instructors.	Students.
Colleges, etc.	358	3,203	30,368
Scientific Schools	76	523	11,603
Schools of Theology	125	577	4,320
Schools of Law	50	196	3,012
Schools of Medicine	106	1,337	11,830
Female Colleges, etc.	225	2,478	23,639
	940	8,314	84,772

New College Buildings.—About a month since, during the Easter vacation, a high board fence was erected on the College campus, enclosing an area of somewhat more than a hundred feet on each side, dividing the School of Mines from the College. Within the enclosure a derrick has been erected, and a large force of men, with steam-drills and other contractor's paraphernalia, are now quarrying and blasting the gneiss rock, excavating for the foundations of a second new college building. This building, to have a long frontage on Forty-ninth street, and with a broad L to connect it with other buildings to be erected on Fiftieth street, will eventually be devoted to the Library and College Chapel. When finished next spring, however, it will be fitted up as the temporary quarters of the Law School, which will then be moved up-town from Great Jones Street.

Next summer, or a year from now, it is proposed to demolish the old Orphan Asylum building, and to erect in its place a new building on Fiftieth street. At the same time additional accommodations will probably be provided for the School of Mines.

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GRADUATE DEPARTMENT.

ARCHIBALD MACMARTIN.

DIED: Of peritonitis, on Saturday morning, May 7th, Archibald, son of the late Peter MacMartin.

Thus has passed away from among us the best-known and most highly esteemed of the alumni of the School of Mines. He was one of the earliest of our graduates, of the Class of 1868, and at his death, President of the Alumni Association. We were all glad and proud to do him honor in his lifetime, and it is fitting that the announcement of the close of his noble and useful life should not be passed over with a few words of formal regret; for he was a man in every sense of the word. Physically, intellectually, morally, socially; in all respects he belonged to the highest rank.

He was born in Jersey City, February 19, 1845, and had thus completed his thirty-sixth year. After his preparatory studies in New York, and at Phillips Academy at Andover, Mass., he entered Princeton College, where he graduated third in rank in 1865. In the autumn of the same year he came to the School of Mines. Here he was among the most earnest and thorough students of his class, and was at his graduation one of those best fitted for the practice of his profession. Of the unusual versatility of his natural gifts and acquirements, many can bear witness. He was equally talented and well-equipped in his professional studies, in general literature, and in the theory of music, which latter was always his favorite recreation, and in his later years became his serious work.

After graduating at the School of Mines he spent some years in foreign travel and study, and returned to this country with added preparation and zeal, both for technical work and for musical criticism.

Had he devoted his energies entirely to scientific pursuits, he might have taken a high rank. His success, technical, if not finan-

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cial, in establishing and conducting, first, a Siemens-Martin Steel Works, and then a zinc furnace at East Providence, R. I., attests this; and to the time of his death he kept up his interest in mineralogy, accumulating a fine and valuable collection.

But he was soon drawn by his natural bent to new fields of labor, and it was in these that he did the work by which he became known to a wider circle. He had an early leaning toward journalism, and had already begun, during his metallurgical work, writing for various newspapers. Among the first of his articles was a series written for the New York *World*, on the Bessemer and Siemens-Martin processes, etc. For a year or more he furnished the *World* reports of sermons of the Rev. Drs. Hall and Taylor, prepared simply from his love of writing. Some of these condensed reports are models of literary excellence, and received the commendation of the preachers themselves.

For upward of a year he was also the regular musical critic of the *World*, and the uniform thoroughness and candor of his work in this department made him known, trusted, and respected by leading musicians, such as Theodore Thomas and Dr. Damrosch.

In the autumn of 1879, he established in the interest of truthful musical criticism, and for the advancement of the science and the art of music, *The Musical Review*, of which he was the chief editor and proprietor up to the time of its incorporation with *The Studio* in February, 1881.

The Musical Review was an undoubted success in the line which Mr. MacMartin laid out for it, and received the highest encomiums of the press and of individuals competent to judge of its merits. But it was in some respects in advance of the times, and not only failed to receive the financial support which it demanded, but, as was to be anticipated, awakened the most active opposition from certain trade influences whose interests it opposed. Its union with *The Studio*, a much inferior paper, was not auspicious, and Mr. MacMartin finally retired from the proprietorship in April, 1881. Such was his work: from a financial standpoint not always remunerative, but this was never necessary and not always sought. Archibald MacMartin's work was not done for the

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need of subsistence—for his fortune was ample—but from the love of work and the recognition of fields for the useful employment of his talents.

Of the man himself; his splendid physical strength, his alert, exact mind, his genial humor, his ready sympathy, and, above all, his noble, generous heart and the purity and integrity of his private life; the simple mention is almost sufficient. He was patient and thorough in investigation, careful and almost timid in forming his opinions, always charitable toward others; and yet no one could be more firm than he in maintaining his convictions, scientific, literary, religious. Strong and manly in body and mind, he was often naïve and playful, even sensitive, as a child. Generous both of his sympathy and his means, he endeared himself to a host of friends in all walks of life. The record of his private benefactions would fill a volume.

He had a remarkable faculty of being "all things to all men," but never changing himself. His own truth and virtue were at all times so plainly manifest, that in his companionship truth and virtue were of necessity the rule. His practical Christianity was daily illustrated, but with a sweetness of temper that drew all men to him. He had no anger except in condemnation of a foul or mean act. Critical by nature, with facilities for gratifying all his wishes, cultivated and refined, he was never known to say a word of unkind criticism of those lacking his advantages. His modesty and consideration for others completed the symmetry of his character.

Such was Archibald MacMartin, and those who knew him well will not call the picture overdrawn. On the morning of Saturday, the 7th inst., after an illness of only six days, which came upon him while he was to all appearance in perfect health, he passed away, leaving this world, so far as his influence, example, and sympathy extended, better than he found it.

WM. ALLEN SMITH.

NEW YORK, May 9, 1881.

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The Alumni Association badges will hereafter be given to graduates only of the School of Mines. The badges are in charge of a committee of three, viz., H. S. Munroe, P. de P. Ricketts, and F. R. Hutton. Applications for the badges should be sent as follows: *Mining Engineering Badge*, H. S. Munroe; *Chemical Badge*, P. de P. Ricketts; *Civil Engineering Badge*, F. R. Hutton.

The design mentioned in our last for the Mining Engineering badge has been perfected, the result being an exceedingly handsome emblem. Designs are now in progress for improved Civil Engineering and Chemical badges.

W. L. Hoyt, E.M., C.E. ('76), writes from Omaha, that, about two years ago, he was obliged by ill-health to resign his position as chemist and assayer to the Omaha Smelting and Refining Works. He has lately decided to give it another trial. The works are doing well, and are the largest in the United States. They are on the same plan as Balbach's works at Newark. He adds: "Please send me a prospectus of your new QUARTERLY. When it is ready I shall want to subscribe."

H. G. Clark, E.M. ('77), Superintendent Cortez Mining Co., Aurora, Nev., sends an interesting sketch of the history of the Aurora Mining Camp, and the work of reopening old mines and restoring old mills, now going on, and promises at some future time a description of the milling process used. Mr. Clark's paper was unfortunately received too late for insertion in this number.

A report "On the Currents and Movements of Material In and Out of the Harbor of Port Jefferson, Long Island," by Fred N. Owen, E.M. ('78), is published in the last annual report of the Chief of Engineers, U. S. A.

R. A. Parker, C.E. ('78), left here about a month ago for Mexico, having accepted a position as engineer on one of the Mexican railroads which are now being pushed with so much energy by American capitalists and railroad men. He writes from Galveston, Texas: "I leave to-morrow for Laredo, Texas (not *Mexico*, as I supposed when leaving), where I expect to be for the next six months or longer. It's as hot as . . . down here, but fresh vegetables, strawberries and cream, and airy, fairy Lilians all around you help to make you more or less contented." An interesting account by Mr. Parker of the Government harbor improvements at Galveston will be found in another column.

Herman Garlichs, E.M. ('80), has started for Rico, Dolores Co., Colorado, where he will make one of the firm of Wannemaker & Garlichs, U. S. Deputy Mineral Surveyors. Mr. Garlichs' work on the U. S. Geological Survey last summer, in the San Juan region, has made him many friends in Colorado, and he starts with every prospect of a busy season.

Frank Klepetko, E.M. ('80), Mining Engineer to the Conglomerate Mining Company, promises us an illustrated paper on "Practical Mining of Lake Superior," giving methods of drifting, stoping, and timbering employed in the copper mines. The paper will be exceedingly valuable, as the Lake Superior

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mines represent the best practice in the country, in the details of underground work of metal mining, being worked on a large scale, and under the superintendence of skilful mine bosses. Mr. Klepetko writes: "The paper will be confined to the description of underground work. Breaking, transportation, and stamping will not be included. I will put in comparative costs of drifting and stoping by hand and with rock-drills.

"I am glad to hear that the class are coming up here this summer. It will help to enliven the country somewhat.

"Our conglomerate is looking well. We are sinking four shafts on it."

It is to be regretted that Mr. Klepetko's paper did not arrive in time for publication in the present number, as it would have proved exceedingly interesting, especially to the students of the Summer School of Practical Mining, who will visit the Lake Superior region this summer.

Theodore Tonnelé, Ph.B. ('80), who has accepted the position of Chemist to the Wampum Cement & Lime Co., Newcastle, Pa., writes to a classmate in this city substantially as follows: "The works here are very extensive, having connected with them a coal-mine, large limestone quarries, and extensive clay-beds, both of cement and fire-clay. Newcastle itself is one of the largest mining and manufacturing towns of Western Pennsylvania. We have gas, water, an opera-house, etc. From my window I can count ten blast-furnaces, three large rolling-mills, a nail-factory, lime-works, and a multitude of smaller establishments. My work consists in analyzing limestones, clays, cements, coal, coke, iron ores, slates, and anything else that happens along. Have made several trips with the secretary of the Company to examine and sample the different deposits. Am a little green as yet, of course, but learn something every hour, and would not have missed the opportunity of coming out here for anything."

A. McC. Parker, E.M. ('80), writes from Silver Cliff that the subject of the concentration of low-grade ores is attracting considerable attention, and that it is probable that a number of concentrating works will be built this summer in different parts of Colorado.

FURNACEVILLE, N. Y., April 21, 1881.

EDITORS SCHOOL OF MINES QUARTERLY:

GENTLEMEN—Being just in receipt of your circular of 7th inst., I hasten to "indorse" your experiment (?) and indicate my intention to "co-operate" with you by sending such items as I have, though they may be stale and of little interest.

I am now modernizing a furnace plant, the first blast of which the "oldest inhabitant" cannot recall, it being originally a charcoal furnace run by water-power, the supply only admitting of operations lasting five months a year. This antique relic has been known as the "Ontario Furnace," and, by various modifications, was so far modernized as to consist of a wrought-iron shell-stack

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set upon cumbersome masonry piers ten feet high, with the ordinary appurtenances, such as pipe-irons, boilers, and steam blowing engine.

The present owners having come in possession of the property in January, 1880, during the "boom," it was considered advisable to get into blast as soon as possible, and avail ourselves of the existing high prices. But alas! the iron market struck "bed-rock" before we could get up steam, and the improvements that should have been made then, but owing to haste were postponed for a future blast, have now been accomplished through the indirect cause of having to blow out in eight months by the combined result of an accident to the water supply and the condition of the old lining.

The chief improvement may be of interest to some of your readers, inasmuch as there were many doubts expressed by persons whose opinions have weight that it would be a "difficult and precarious undertaking;" the same was to replace the stone piers or base of the stack by a cast-iron ring-plate and cast-iron columns, without disturbing the wrought-iron casing, eighteen feet in diameter and forty feet high, with a fourteen-inch lining of brick, and with the "top-house" and two large flues attached. The ring-plate was in six segments and to rest upon six columns. The thing was accomplished without disturbing more than twenty brick of the lining or the stack settling any *appreciable* amount.

I simply give you the fact as a novel item for your paper, and should you desire the details of the operation I will be pleased to furnish them.

Be assured that I will co-operate with you to the best of my ability, and that you have my hearty congratulation for the successful manner in which the issue of the SCHOOL OF MINES QUARTERLY just received is gotten up. And, with best wishes for your success, I am,

Yours truly,

E. M. PARROTT.

LIST OF GRADUATES.

1878.

William James Adams, A.B., A.M., E.M., Chlorinator, Plumas Gold Milling Co., Greenville, Plumas Co., Cal.

Marcus Benjamin, Ph.B., care E. B. Benjamin, 6 Barclay street, N. Y. City; residence, 43 East Sixty-seventh street, New York.

Charles Edward Blydenburgh, A.B., A.M., E.M., Mining Expert and Prospector, Rawlins, Wy. T.

Robert Elmer Booraem, E.M., Engineer Evening Star Mine, Box 2204, Leadville, Col.

George Charles Brinckerhoff, E.M., care Francke & Co., Havana, Cuba.

Willard Parker Butler, E.M., address, care of Smith, Payne & Smith, London, Eng.

Alexander Ramsay Cushman, Ph.B., Ph.D., 128 East Sixteenth street, New York City.

John Woodbridge Davis, C.E., Ph.D., Engineer and Geologist to Grundy Mining Co., Tracy City, Grundy Co., Tenn.

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Walter B. Devereux, A.B., A.M., E.M., Mining Engineer, care Butler, Stillman & Hubbard, 111 Broadway, New York.

Isaac Wyman Drummond, E.M., Ph.D., Chemist, F. W. Devoe & Co., 436 West Twenty-second street, New York.

Orrien Pinkerton Downing, Ph.B., Drugs. Oakland, Alameda Co., Cal.

Walter Graeme Elliot, E.M., C.E., Ph.B., Expert on City Water Supply for the Tenth Census, address, 741 Fifth avenue, New York.

Anton Fernekes, E.M., Chemist, Billing & Eiler's Smelting Works, Leadville, Col.

Harry Leopold Haas, Ph.B., Chemist, Zucker & Levett's Rouge Factory, 540 West Sixteenth street, New York.

Yothinosuke Hasegawa, E.M., Ph.D., University of Tokio, Tokio, Japan.

Henry Albert Hodges, E.M., Chief Clerk, Wm. D. Andrews & Bros., Drive Wells, 229 Broadway, New York.

Edward Henry Holden, C.E., Surveyor and Civil Engineer, One Hundred and Sixty-ninth street and Boston avenue, Morrisania, N. Y.

William Hollis, C. E., Mining Expert, Galveston, Harrisburg & San Antonio R. R., Harrisburg, Texas.

Elias Mattison Johnson, Ph.B., I. G. Johnson & Co., Malleable Iron, Spuyten Duyvil, N. Y.

Gilbert Henry Johnson, Ph.B., Chemist, I. G. Johnson & Co., Spuyten Duyvil, New York.

Corydon Powell Karr, Ph.B., Metallurgist, Powell Silver and Metal Co., foot of Clay street, Newark, N. J.

Benjamin Bowden Lawrence, E.M., Supt. and Mining Eng., Montezuma Mining Co., Montezuma, Col.

Frank Lyman, E. M., address, care J. B. Taylor, Austin Friars, London, Eng.

Edward Austin McCulloh, Ph.B., Chemical Expert, Chicago, Burlington & Quincy R. R., Aurora, Ill.

Nawokichi Matsui, Ph.B., Ph.D., Instructor in Qualitative Analysis, University of Tokio, Tokio, Japan.

George Barrow Morewood, E.M., Ph.D., 34 South street, New York.

Gouverneur William Morris, E.M., Myers, Rutherford & Co., 42 Exchange Place, New York.

Charles Edward Munsell, Ph.B., Milk Inspector, N. Y. Health Dept.; address, Glen Cove, L. I.

Henry Morgan Murphy, E.M., Chemist, H. H. Murphy & Co., Varnish Makers, 238 McWhorter street, Newark, N. J.

Kingo Nambu, E.M., University of Tokio, Tokio, Japan.

Spencer Baird Newberry, E.M., Ph.D., Student, Berlin, Germany.

James Atkin Noyes, Ph.B., 155 Remsen street, Brooklyn, N. Y.

Owen Frederick Olmstead, C.E., care of N. R. Davis & Co., Cheyenne, Wyoming Ter.

Frederick Nash Owen, E.M., Hydraulic Engineer, 19 West Fifty-sixth street, New York.

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Cortlandt Edward Palmer, E.M., Engineer's Office, Pennsylvania Co., Tenth and Penn streets, Pittsburg, Pa.

Richard Alexander Parker, C.E., Engineer, Mexican National R. R., Laredo, Texas.

Vicente Felix Pazos, E.M., 122 Calle Zavala, Lima, Peru.

Nelson Williams Perry, E.M., Mt. Auburn, Cincinnati, O.

William Strieby, A.B., E.M., Professor State School of Mines, Golden, Col.

Bailey Willis, E.M., C.E., U. S. Geological Survey, Newport, R. I.

1879.

Nathaniel Lord Britton, E.M., Asst. in Geology, School of Mines, Columbia College.

Leo George Cloud, A.B., E.M., Supt. Little Chicago Mining Co., Kokomo, Summit Co., Col.

Harry Clay Cornwall, E.M., Irwin, Gunnison Co., Col.

Louis Philippe De Luze, C.E., 48 Pine street, New York.

George Spencer Eastwick, C.E., Chemist in Sugar Refinery, Quebec, Can.

Louis Francis Haffen, A.M., C.E., Brewer, One Hundred and Fifty-second street and Courtland avenue, New York.

Charles Sumner Harker, E.M., care Bodie Tunnel Co., Bodie, Cal.

Nathaniel Hathaway, Ph.B., Private Asst. to Dr. Waller, School of Mines, Columbia College.

Herman Hollerith, E.M., Expert U. S. Census, 161 East Sixty-first street, New York.

Charles Arthur Hollick, Ph.B., Supt. Mexican Mine, Bear Valley, Mariposa Co., Cal.

Isaac Bradley Johnson, E.M., Chemist, Hoosick Malleable Iron Works, Hoosick Falls, N. Y.

Robert Andrew Johnston, C.E., Asst. Sanitary Engineer, N. Y. Board of Health, address, Scarsdale, N. Y.

Edward Cabet Koch, E.M., P. O. Box 2649, Leadville, Col.

Thomas Haight Leggett, Jr., E.M., Batopilas Silver Mining Co., Batopilas, Chihuahua, Mexico.

Edwin Ludlow, E.M., U. S. Engineer, 1619 Chestnut street, Philadelphia, Pa.

Charles Wells Marsh, Ph.B., Asst. in Quantitative and Qualitative Chemistry, Princeton College, N. J.

Theophilus Smith Mathis, E.M., County Surveyor, Ouray, Ouray Co., Col.

Ralph Edward Mayer, C.E., 218 East One Hundred and Twelfth street, New York.

Hubert John Merwin, E.M., Grundy Mining Co., Tracy City, Tenn.

George Fanshawe Milliken, E.M., New York (now in Colorado?).

Otis Mortimer Munroe, Ph.B., 102 East Forty-fifth street, New York.

Joseph William Knight Neftel, C.E., Expert U. S. Census, 16 East Forty-eighth street, New York.

James Nesmith, E.M., 256 Henry street, Brooklyn, N. Y.

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Charles Milton Noble, E.M., General Foreman, Woodstock Iron Works, Anniston, Ala.

Robert Dunn Rhodes, E.M., Ontario Mine, Park City (Parley's Park), Utah.

William Bell Stephen Reed, E.M., 857 Sackett street, Brooklyn, N. Y.

Francis Morris Rutherfurd, E.M., Assayer, Prescott, Arizona.

Gardner Hutchinson Sheldon, E.M., Corralitos, Chihuahua, Mexico.

George Cameron Stone, Ph.B., Chemist, Potter & Riggs, St. Louis, Mo.

Henry Fowler Starr, Ph.B., Chemist, Newark Steel Works, Newark, N. J.

John Richard Suydam, Jr., E.M., 43 East Twenty-second street, New York.

Granville Whittlesey Williams, 388 Clinton street, Brooklyn, N. Y.

1880.

Alfred Lockwood Beebe, Ph.B., Private Asst. to Dr. Ricketts, School of Mines, C. C., residence, 58 East Sixty-eighth street, New York.

Frank Parkinson Benjamin, C.E., Student, Berlin, Europe, address, 31 West Nineteenth street, New York.

Frederick Denison Browning, E.M., Mining Engineer and Metallurgist to the Cusihuiriachic and the Sta. Eulalia Mining Companies, care Ketelsen y Degetan, Chihuahua, State of Chihuahua, Mexico.

William Frederic Brugman, Ph.B., Assistant Chemist, South Carolina Agricultural Department, Chapel Hill, S. C.

Nathaniel Butler, E.M., care Henry Russell & Co., 42 Barclay street, New York.

Alfred Daniel Churchill, M.S., Ph.B., E.M., Asst. in Drawing, School of Mines, C. C.

Edwin Perry Clarke, E.M., Mining Engineer, Box 1229, Leadville, Col.

Louis George Engel, E.M., Engineer, with the Brooklyn Sugar Refinery, Brooklyn, N. Y.

Robert Otto Francke, C.E.

Herman Garlichs, E.M., Consulting Mining Expert, address, Rico, San Juan Co., Col.

Wilkins Updike Greene, Ph.B., U. S. Census, address, 38 South Portland avenue, Brooklyn, N. Y.

James Leal Greenleaf, C.E., Expert U. S. Census, address, 23 West Twelfth street, New York.

Albert Peter Hallock, Ph.B., Chemist, N. Y. Gaslight Co., residence, 249 East Thirty-first street, New York.

Henry Harmon Hendricks, Ph.B., Chemist, A. R. Ledoux & Co., 17 Cedar street, New York; residence, 512 Fifth avenue, New York.

Louis Mosher Hooper, C.E., Draughtsman, U. S. Census, Fifty-second street and Vanderbilt avenue, New York.

Theodore M. Hopke, Ph.B., Chemist, A. R. Ledoux & Co., 17 Cedar street, New York; residence, Hastings-on-Hudson.

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Edward Henry Hudson, C.E., 434 Madison avenue, New York.

Frank Klepetko, E.M., Asst. Supt. Delaware Mine, Keweenaw Co., Mich.

Wheaton Bradish Kunhardt, E.M., Student, Germany; address, 32 Beaver street, New York.

Joseph Godley Mattison, Ph.B., Chemist, A. R. Ledoux & Co., 17 Cedar street, New York.

Charles August Meissner, Ph.B., Chemist, Joliet Iron and Steel Works, Joliet, Ill.

Juan Adelberto Narvarro, C.E., 251 West Forty-fourth street, New York.

Andrew McClean Parker, E.M., U. S. Deputy Mineral Surveyor, Silver Cliff, Col.

John Randolph Parks, E.M., Consulting Engineer, 113 Penn street, Brooklyn, N. Y.

Frederic Augustus Potts, Jr., Ph.B., Student, Europe.

Henry Alvord Robinson, Ph.B., Law Student, with Robinson, Scribner & Co., 102 Broadway, New York; residence, 19 East Sixty-second street, New York.

Ferdinand Ruttmann, Jr., E.M., Mining Engineer, Tilly Foster Iron Mine, Brewsters Station, N. Y.

George Singer, E.M., Pittsburg, Pa.

George Harton Singer, E.M., Singer, Nimmick & Co., Pittsburg, Pa.

Wallace Augustus Smalley, E.M., Surveyor and Assayer, Georgetown, New Mexico.

Maxwell Smith, C.E., 121 West Twenty-first street, New York.

Theodore Tonnelé, Ph.B., Chemist, Wampum Cement and Lime Co., Newcastle, Lawrence Co., Pa.

Charles Herbert Torrey, Ph.B., Asst. in Qualitative Analysis, School of Mines, C. C.; residence, 53 West One Hundred and Twenty-eighth street, New York.

Joseph Walker, Jr., C.E., 289 Fifth avenue, New York.

Herbert Allen Wheeler, E.M., U. S. Geological Survey; address, P. O. Box 240, Salt Lake City, Utah.

We note the following corrections of the graduate list published in the March QUARTERLY:

1870. John L. Lilienthal, E.M., San Francisco, Cal.

1872. Peter Townsend Austen, Ph.B., Ph.D., F.C.S., Professor of Analytical and Applied Chemistry, Rutgers College, New Brunswick, N. J.

1875. Bayard Taylor Putnam, E.M., U. S. Geological Survey; address, 27 West Twenty-third street, New York.

1877. Henry Gilbert Clark, E.M., C.E., Superintendent Cortez Mining and Milling Co., Aurora, Nev.

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BOOKS ADDED TO THE SCHOOL OF MINES LIBRARY SINCE OCTOBER, 1880.

ENGINEERING.

Aneroid Barometer; its Construction and Use. Pocket edition. 106 pp. New York, 1878.

Appleby, C. J. Illustrated Handbook of Machinery. Sect. 1. Prime Movers. Sect. 2. Hoisting Machines. Sect. 3. Pumping. 8vo, 404 pp. London, 1880.

Briot, Charles. Théorique Mécanique de la Chaleur. 8vo, 352 pp. Paris, 1869.

Buck, J. H. Watson. The Construction of Large Tunnel Shafts. 8vo, 51 pp. London, 1880.

Clark, D. Kinnear. Fuel: its Combustion and Economy. 8vo, 394 pp. New York, 1879.

Clarke, Col. A. R. Geodesy. 8vo, 356 pp. Oxford, 1880.

Clevenger, Shobal V. A Treatise on the Method of Government Surveying. 12mo, 200 pp. New York, 1877.

Drinker, Henry S. Tunnelling, Explosive Compounds, and Rock-Drills. 4to, 1,031 pp. New York, 1878.

Davies, D. C. Metalliferous Metals and Mining. 8vo, 432 pp. London, 1880.

Dubois, A. Jay. The Principles of Thermodynamics. 8vo, 637 pp. New York, 1880.

Evrard, Alfred. Traité Pratique de l'Exploitation des Mines. 8vo, 378 pp. Paris, 1879.

——— Les Moyens de Transport Appliqués dans les Mines, les Usines et les Travaux Publics. 8vo, 214 pp. and Atlas. Paris.

Giesler, E. A. Complete Tables of Frog Angles and Distances for Turnouts from Straight Lines and Curves. Pamphlet, 10 pp. College Point, L. I., 1878.

Gurden, Richard Lloyd. Traverse Tables for the Use of Surveyors and Engineers. 4to, 270 pp. London, 1880.

Gwilt, Joseph. Encyclopædia of Architecture. 8vo, 1,395 pp. London, 1876.

Haskoll, W. Davis. The Practice of Engineering Field Work. 8vo, 184 pp. London.

Hell, Alfred. The Chemistry of the Mine. Pamphlet, 67 pp. Birmingham.

Jackson, Lewis D'a. Aid to Survey Practice. 8vo, 350 pp. London, 1880.

Munroe, Henry S. The Losses in Copper-Dressing at Lake Superior. 8vo, pamphlet, 50 pp. New York, 1880.

——— On the Weight, Fall, and Speed of Stamps. 8vo, pamphlet, 16 pp. New York, 1881.

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Murray, David. Manual of Land Surveying. 8vo, 259 pp. New York, 1879.
Nicolls, William J. The Railway Builder. Pocket edition, 231 pp. Philadelphia, 1878.
Percy, C. M. Winding and Overwinding; a Description of the Chief Detaching Hooks in Use. Pamphlet, 20 pp. Wigam, 1880.
Reuleaux, F. The Kinematics of Machinery. 8vo, 622 pp. London, 1876.
Rigg, Arthur. A Practical Treatise on the Steam-Engine. 4to, 312 pp. London, 1878.
Schunk, William F. The Field Engineer. 12mo, 318 pp. New York, 1880.
Thurston, Robert H. Friction and Lubrication. 8vo, 212 pp. New York, 1879.
Ulrich, Josef. Anwendung der Tangenten und Sehnen bei der Anfertigung von Grubenplänen. 8vo, 28 pp. Leipzig, 1879.
Uhland, W. H. Handbuch für den praktischen Maschinen-Constructeur. 25 Lieferungen. Leipzig, 1881.
Wolpert, Dr. Adolph. Theorie und Praxis der Ventilation und Heizung. 8vo, 980 pp. Braunschweig, 1880.

CHEMISTRY, METALLURGY, AND PHYSICS.

Agricultural Experiment Station, New Jersey. First Annual Report, 1880. Pamphlet, 68 pp.
Ayres, George B. How to Paint Photographs. 8vo, 208 pp. New York, 1878.
Büchner, Th. D. Lehrbuch der Anorganischen Chemie. 8vo, 1,012 pp. Braunschweig, 1878.
Capron, J. Rand. Auroræ; their Characters and Spectra. 4to, 207 pp. New York, 1879.
Commerson, E. et E. Laugier. Guide pour l'Analyse des Matières Sucrées. 8vo, 339 pp. Paris.
Elsner, Dr. Fritz. Die Praxis des Nahrungsmittel Chemikers. 8vo, 180 pp. Leipzig, 1880.
Estabrooke, E. M. The Ferrotype, and How to Make it. 8vo. 171 pp. New York, 1880.
Flügge, C. Dr. Lehrbuch der Hygienischen Untersuchungsmethoden. 8vo, 602 pp. Leipzig, 1881.
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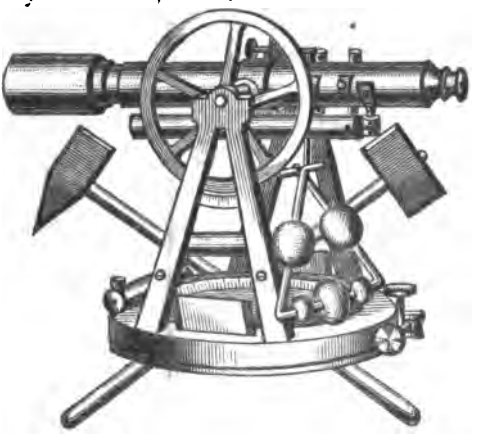

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